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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 10, 2007

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

SUBCOMMITTEE ON REGULATORY POLICIES AND PRACTICES

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TUESDAY,

JULY 10, 2007

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 10:30 a.m., Dr. William J. Shack, Chairman, presiding.

MEMBERS PRESENT:

WILLIAM J. SHACK	Chairman
SAID ABDEL-KHALIK	ACRS Member
GEORGE E. APOSTOLAKIS	ACRS Member
J. SAM ARMIJO	ACRS Member
MARIO V. BONACA	ACRS Member
MICHAEL CORRADINI	ACRS Member
THOMAS S. KRESS	ACRS Member
OTTO L. MAYNARD	ACRS Member

NRC STAFF PRESENT:

ROBERT PRATO

JOCELYN MITCHELL

RICHARD SHERRY

JOSEPH JONES

JASON SCHAPEROW

JIMMY NEROKA

CHARLES TINKLER

JOHN MONNINGER

MIKE SHIU

ATA ISTAR

JEFF GAZOR

FAROUK ELTAWILA

DONALD DUBE

SELIM SANCAKTAR

HOSSEIN NOURBAKSH

I-N-D-E-X

P R O C E E D I N G S

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 Said Abdel-Khalik, Sam Armijo, George Apostolakis, Mario Bonaca, Mike Corradini, who will be here shortly, hopefully, if airlines are working this morning, Tom Kress and Otto Maynard.

The purpose of the meeting is to discuss the status of the staff's effort associated with the state-of-the-art reactor consequence analysis, SOARCA project.

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

Dr. Hossein Nourbaksh is the designated federal official for this meeting.

The rules for participation in today's meeting have been announced as part of a notice of this meeting previously published in the Federal Register on June 22nd, 2007, and amended on July

3rd, 2007. A portion of today's meeting may be closed to prevent disclosure of information, the premature disclosure of which is likely to significantly frustrate implementation of a proposed Agency action pursuant to 5 USC 5.52 BC 9(b).

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

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting. So to forgo any comments here, this morning, and just proceeding with the meeting, and I'll call upon Jimmy Neroka of the Office of Nuclear Regulatory Research to begin.

MR. NEROKA: Thank you. My name is Jimmy Neroka. I'm a branch chief for the Special Projects Branch in the Office of Research.

First, I want to thank the ACRS for the time and the opportunity for us to come here today and discuss this very important Agency activity.

This is a joint effort by multiple

offices in the NRC. We have the Office of Research, NSER, NRR, and staff members from OPA. We also have staff members from the Office of the EDO that are team members for this very important Agency activity.

This activity is supported by Sandia National Laboratories and it's a joint effort within the Agency, and also we have the support of the lab.

We realize, and we acknowledge that the ACRS has a very important role in getting this project accomplished, and, you know, we've been to the ACRS in the past. We are here today. We'll be back in the afternoon. The staff expects to be back to the subcommittee again, ultimately, before we go to a full committee, so we understand this and we will work with the staff members to be sure we are -- you know, the schedule and the future plan to come is well laid out.

I just want to point out we are committed to conducting this project. We are fully committed and will do this. We don't have the full complement of plans we need to run this activity and we are working on getting our full complement.

We've started with a couple of plans, we'll discuss those, you know, in detail, later on

this afternoon. But we also have additional plans we're seeking and we definitely will get the best plans to run this project.

When the staff members start talking about their technical areas, they'll introduce themselves, and just, you know, again, thanks for the opportunity and I hope we are able to provide all the information you need today. Thank you.

CHAIRMAN SHACK: Are you getting active participation from Peach Bottom and Surry, or you're just sort of grabbing information because it's available from them?

MR. NEROKA: Yes. We are. Now to Analysis.

MR. PRATO: Good morning. I'm Bob Parto. I'm the project manager for SOARCA, and this morning we're going to be covering process information. I'm going to be giving the overview and after the overview, experts from each of the disciplines are going to go into the details of each of the areas that I cover.

SOARCA. The goal is to develop a state of the art, more realistic evaluation of severe accident progression, radiological release and off-site consequences with dominant accident sequences,

and to replace such studies as new Regulation CR 2239, which is the technical guidance for citing criteria development.

DR. APOSTOLAKIS: What's the date of that report?

MR. PRATO: 1982, George. That's the Sandia 1982 citing study. No comment on that.

The objectives for SOARCA is to determine the best estimate of the radiological consequences for select U.S. operating reactor sites.

Two is to evaluate and update analytical methods and models for realistic evaluation of severe accident progression and off-site consequences.

To include mitigative measures and plant improvements from the past 25 years of operating experience, that have the potential to reduce off-site consequences, and to use updated emergency planning model assumptions. And finally, to incorporate effective risk communication.

DR. APOSTOLAKIS: Now "best estimate" means what? Does it include uncertainties, in other words?

MR. NEROKA: We are going to do some

uncertainty analysis.

DR. APOSTOLAKIS: Some, or full?

CHAIRMAN SHACK: Enough to get a best estimate.

MR. NEROKA: That's right.

DR. APOSTOLAKIS: No, but I mean, the uncertainties at the end are very large, so -- and especially if you want to have effective risk communication. I mean, you have to worry about the uncertainties, don't you?

MR. TINKLER: Charles Tinkler from the NRC Office of Research staff. Yes, indeed. The initial focus will be on using our best modeling, our best practices within that modeling, but the longer-term effort is to include an integrated uncertainty analysis for both the Level 2 and Level 3 issues. We will do work to determine what appear to be the principal parameters that pose the greatest uncertainty, but then to propagate them through in a consistent way as opposed to single selected sensitivities, cascaded on top of one another.

DR. APOSTOLAKIS: So "best estimate" for the time-being means point, some point --

MR. TINKLER: Point guidance; yes.

CHAIRMAN SHACK: But it means you're not doing deliberately conservative analysis, is what it really means.

MR. TINKLER: Absolutely correct.

DR. APOSTOLAKIS: Unless they have to.

CHAIRMAN SHACK: Yes. Unless there's no choice.

MR. TINKLER: Unless, in both the Level 2 and in the Level 3, we will -- in some cases we will have a mean value. In other cases, we will have what is our best understanding of a central value.

CHAIRMAN SHACK: That's fine.

DR. KRESS: Your goal talks about doing this predominant accident sequences. Do you mean dominant with respect to CDF or dominant with respect to prompt fatalities, dominant with respect to latent fatalities? Or what do you mean by dominant?

MR. PRATO: It's with respect to CDF, initially.

DR. KRESS: With CDF.

MR. PRATO: Yes, sir.Construction Corporation

MR. TINKLER: The only point -- the

original objective was to focus on events with a release frequency of 10 to the minus six or greater. Because we don't readily have available to us a tool for selecting such events, because we typically focus on CDF --

DR. KRESS: That was going to be my next question.

MR. TINKLER: On CDF, we are screening on the basis of CDF, but we will also, we are also examining less frequent, lower frequency scenarios that pose special circumstances, such as bypass of the containment. So Rick Sherry will talk about that in more detail but our first screening will be on CDF because it is the readily available metric for us to use. But because we know that that alone does not portray the entire picture of risk, we're looking at lower frequency events.

DR. APOSTOLAKIS: But we'll come back to this selection later, because I have a few questions myself?

MR. TINKLER: Yes.

DR. APOSTOLAKIS: Okay.

MR. PRATO: As for communications, we had a press release issued on May 7th, 2007. OPA prepared a fact sheet. We have a Web page,

frequently asked questions and --

DR. APOSTOLAKIS: What's OPA? Sorry.

MR. PRATO: -- frequently asked questions, and links to related sites, that are going on the NRC Web site some time in the relatively near future, within the next month or so.

As for the project plan, the initial scope will be limited to not more than eight plants, representing the spectrum of plant vendors and technology. We will start with the assessment of one BWR and one PWR. The BWR that we first selected was Peach Bottom and the PWR is Surry, and we selected those two primarily because of the advanced models we have already in place for those two sites.

CHAIRMAN SHACK: And this is going to be real plants on real sites? You're not doing some sort of 80th percentile generic site?

MR. NEROKA: It's site-specific. Yes, sir.

DR. APOSTOLAKIS: How many studies are there on Surry?

[Laughter]

DR. APOSTOLAKIS: It's incredible.

MR. PRATO: An industry.

DR. APOSTOLAKIS: Huh?

MR. PRATO: It's an industry.

DR. APOSTOLAKIS: It started with WASH-1400, right? And they did ID, they updated --

MR. PRATO: 1150.

DR. APOSTOLAKIS: So at least you have good information.

CHAIRMAN SHACK: No. You have a long history of information.

[Laughter]

DR. APOSTOLAKIS: Well, you have to be precise, I guess.

MR. PRATO: Once we're done with the first two plans, we'll go on and complete the rest of the initial scope and then we will report to the Commission with a recollection on how to proceed with the remaining plans. Once all of that is done, the results will be compiled and released to the public after the project is totally complete.

DR. APOSTOLAKIS: So these are results then, I mean judging from what you said, but just updating the results. Is there any actions that are going to be taken using those results, any regulatory action, or decision, or are we just producing results and communicating to the public?

What's the purpose of this, to replace

an old study by another study?

MR. NEROKA: I can try that. The sole purpose is to replace the old outdated studies. That's clearly --

DR. APOSTOLAKIS: That's all?

MR. NEROKA: That's all. It's not intended for any regulatory problems.

DR. APOSTOLAKIS: And the reason is that these old studies are misused?

MR. NEROKA: That's true.

MR. PRATO: Misused and outdated. Misinterpreted.

MR. NEROKA: We have better knowledge, we have better means to develop more accurate information. That's it.

DR. APOSTOLAKIS: But I think tomorrow, or the day after, we will review another project on protective actions, and it would seem to me that the results of this study would be very relevant to deciding what protective actions to take.

MR. PRATO: I think that's right.

DR. APOSTOLAKIS: What did you say?

MR. PRATO: I said it might but right no there is no --

[Laughter]

DR. APOSTOLAKIS: So somebody will use these results, I hope. I mean, these are not projects in parallel that have nothing to do with each other, because how can you decide on protective actions if you have outdated information? And you guys will bring the information to date. But that's not your concern. We understand that.

MR. TINKLER: But that is a very valid point. That key individuals that are working on the protective action recollection project are closely affiliated and working directly on this project as well.

DR. APOSTOLAKIS: Okay.

MR. TINKLER: So the fact that they're moving along and about the same -- well, actually, one's a little ahead of the other, but we do expect that there will be exchange of information between the two and that one project will inform the other, frankly.

DR. BONACA: I mean, this is the issue of whether another scenario in the PAR study is credible. Is it?

MR. TINKLER: There -- because -- I don't want to speak for Randy Sullivan, in detail here, but there is the tradeoff of issues associated

with EB being a defense-in-depth sort of consideration, but also being mindful of the fact that while it is a defense in depth, it should be focused on realistic scenarios. So we are seeing exchange of information between the two.

One project was head of the other for a while, or has been ahead of the other, but to the extent, like I said, to the extent insights from one project will be integrated into the other. So we're very keenly aware of two projects and how they relate to one another.

MR. JONES: I'm Joe Jones with Sandia and I'm sitting here because Randy Sullivan is out of town. I happen to be on both projects, leading the PAR project, and Randy Sullivan is on both projects as well.

DR. KRESS: Are your consequences going to be limited to prompt and latent fatalities, or are you going to do the economic impacts, which can be done at max.

MR. PRATO: Right now, it's going to be limited to the prompt and latent fatalities.

DR. KRESS: As long as you're doing this, why not do the economics also? I mean, is that much of an increment in effort? It gets kicked

right out of MACCS.

MR. PRATO: Right now, that's where we're limiting the scope. It may be expanded. We may be asked to go forward. The staff may make that recommendation. But right now, it's our scope is limited just to latent and immediate fatalities.

This a flow diagram of the overall project. I'm going to cover each one of these boxes as an overview, later on. Each subject matter expert is going to get up and get into the specifies. So my initial objective is to just familiarize you with the project and then each of the technical area experts are going to go into detail.

DR. APOSTOLAKIS: Before you leave that chart, when will you be finished for the first two plants? You know, when will we see the results for Surry and for Peach Bottom?

MR. PRATO: Currently, we're scheduled to complete those in September of this year.

DR. APOSTOLAKIS: Really? So you're coming back to the committee in the fall?

MR. PRATO: Yes, sir.

DR. APOSTOLAKIS: And then we'll write a letter. Is that the plan?

CHAIRMAN SHACK: We can write a letter any time.

DR. APOSTOLAKIS: Well, the full committee has to be briefed and --

CHAIRMAN SHACK: That's true but --

MR. PRATO: We're going to probably approach the CNF for this meeting, about our next meeting, and we plan to come to you in the fall when the initial two plans are completed.

DR. APOSTOLAKIS: Okay.

CHAIRMAN SHACK: But it seems like an appropriate point for a letter. I mean, we'll have some substance, some concrete results.

MR. PRATO: Okay.

DR. KRESS: If I were Hal Lewis, I'd point out the misspelling on that slide but --

MR. PRATO: I'm sorry, sir?

DR. KRESS: If I were Hal Lewis, I'd point out the misspelling on that slide; but since I'm not I won't.

MR. PRATO: All right. Tell us where it is.

DR. KRESS: Emergency preparedness.

MR. PRATO: That's right. I apologize.

MR. PRATO: With regards to sequence

selection, internal events. We performed an initial screening, use of enhanced Bomb model to screen out low CDF initiating events, and sequence groupings that eliminated approximately 10 percent of the overall CDF. We identified and evaluated dominant cut sets for the remaining sequences, determined system and equipment availability and accident sequence timing.

We grouped sequences with similar times to core damage and equipment unavailability. The results will include internal dominant sequence groupings with a CDF greater than or equal to one E to the minus 6, or one E to the minus 7 for pipe after that.

DR. APOSTOLAKIS: Now these are the frequencies of the sequences, not just the initiating event; correct?

MR. PRATO: That's sequences.

MR. SHERRY: Almost there, the frequencies of groups of sequences.

DR. APOSTOLAKIS: Yes, but not just the initiating.

MR. SHERRY: Right.

DR. APOSTOLAKIS: Now there is an interesting piece of information, though, that we

got in the context of this other protective action project. We got the report from EPRI, entitled "Risk-Informed Evaluation of Protective Action Strategies for Nuclear Plant Off-Site Emergency Planning." And they calculate also early and latent deaths, and they conclude that the early fatality and early injury risks with a 10 to the minus 7 per year cutoff for the accident sequence frequencies addressed are zero over the entire EPZ.

And then they did the calculation again with no cutoff frequency, and they found, you know, they developed the curves.

So it seems to me that doing what you're proposing here probably will not lead to accurate curves. I don't know how they managed to do it without any cutoff sequences, cutoff frequencies, but apparently they can do it, or maybe they used 10 to the minus 18, or something.

But it's very interesting that they reached that conclusion, and since your goal is develop fatality curves, according to what they did, you'll probably find zero.

MR. PRATO: Now we're going to go over the process in a little more detail to help you understand, and then this afternoon we're going to

go over some initial results, and I think as we're going through those initial results, you may get a better perspective of what we're --

DR. APOSTOLAKIS: My question is really, Do you need this? Do you need to have a cutoff frequency? I mean, why don't you -- because in my mind, the cutoff frequency is determined, having in mind, roughly, what the order of magnitude of the frequency of the event you are evaluating is.

So, you know, for core damage we say, yes, the frequency will be at about 10 to the minus 5, or somewhere there. So if I keep the, all the sequences that have frequencies, maybe lowered by a factor of a thousand, that'll be okay.

So when I go to the fatalities, I should follow similar logic, and say, you know, the kinds of frequencies I expect to see are in the neighborhood of 10 to the minus 7, or so, so I should keep "freq" sequences that are maybe a factor of a 100 or a 1000 lower.

Put it another way. If you are calculating deaths, is it really reasonable to use a cutoff frequency of the CDF? You should use a cutoff frequency on the whole sequences of the latent deaths, and since EPRI claims that they can

do it without any cutoff frequencies, I'm wondering why we can't do that. We should be able to do it, I mean, if they can do it.

MR. TINKLER: It's not -- it's clearly not a question of whether or not it can be done. The question is, is what is the meaningfulness of a 10 to the minus 12 sequence group. You know, 10 to the minus 12 times point one early fatalities is bigger than any other numbers times zero. Okay.

So I mean, you can do that, but for effectively communicating what we think is the real risk for nuclear plant plants, we believe that a cutoff, to focus on the dominant frequencies, is appropriate.

Now I presume that EPRI's exercise was to show that the rest of that stuff didn't make a lot of difference in any -- I mean, they're multiplying in terms of frequencies, so they're going to come up with a very low risk number.

DR. APOSTOLAKIS: Well, precisely, because the terms are so low, in frequency.

MR. TINKLER: But if you wanted to communicate consequences --

CHAIRMAN SHACK: That's right. You do a consequence study or a level --

MR. TINKLER: -- come up, whether we're communicating consequences or risk, or consequences and risk, but if you're communicating consequences to replace the earlier study, then you need some reasonable frequency cutoff.

DR. APOSTOLAKIS: Well, that's the question. What is reasonable? But I mean, I wouldn't raise the issue if they had said, you know, here is a curve with this cutoff frequency and it changes a little bit with no cutoff.

But the differences between zero and the curve. So that seems to me to be a pretty significant difference. But what you said makes sense. But again, the issue is do you consider sequences that dominate at the CDF level, when you intend to go all the way to deaths? Or should you consider sequences all the way to deaths and put a cutoff level there? And I think that's the difference. What is a reasonable thing to do?

I mean, if -- again, I was very surprised when they said, you know, it's zero, but now if you put, include all of them, you get a curve. The curve is very low in frequency, there's no question --

MR. TINKLER: Of course. That's --

[Simultaneous conversation]

DR. APOSTOLAKIS: But in terms of communication, it seems to me if the public finds out that you're communicating extremely low or next to zero deaths, because of the cutoff frequency, I mean, that would be a public disaster, actually.

CHAIRMAN SHACK: Yes, but I mean, it comes back to what Charlie says. What's the consequences of an accident that happens once a billion years?

DR. APOSTOLAKIS: If you have to go to deaths, you have to say something about that. If it's a billion years, it's a billion years. I mean, that's what the best technology right now tells us.

But to say that you get zero, or something, you know, insignificant, because you cut off the frequency of the sequences, that doesn't make sense to me.

MR. TINKLER: Well, I understand that.

It's just that the other argument is of course someone can do the calculation and the multiplication. But if you started looking really hard at the quantification of 10 to the minus 10 and 10 to the minus 12 sequences, and in a consistent, fully consistent way, what might be the initiator of

such a thing, it's not clear to me that much is gained in your overall knowledge of risk, if anything.

DR. APOSTOLAKIS: On the other hand, I can turn the argument around and say that would be a great thing to communicate to the public, and show those curves, and then put what he said earlier on the myth and say now, what is the meaning of a sequence that has such a very, very low frequency? I mean, we're in fantasyland now.

The thing I'm trying to avoid is to have a situation where we do this study and then because of the cutoff frequency, the results are not representative of what one would gather if there were no cutoff frequency.

I don't know. Are you aware of this study that EPRI did? All I'm saying is maybe you guys should go and look at what they did, and maybe you will disagree. I don't know. But if you look at the face of it, I mean, it's really disturbing. And they repeat that several times, they have the curves, they say, you know, this is what you get without the cutoff frequencies and this is what you get with.

So that's all I'm saying. I mean, this

is something that should be taken into account at some point. And, in general, it seems to me, if you have -- again, if you calculate something and you want to use a cutoff frequency, you do some sensitivity studies there, and you say, okay, if I make the cutoff 10 to the minus 8, do I see a significant change in the results? And if you do, then you keep it. Go 10 to the minus 9. I mean, these things are not decided based on some theory. It's really brute force. If I may --

CHAIRMAN SHACK: Maybe we can come back to this in the afternoon, George, when we see some of the results.

DR. APOSTOLAKIS: We will.

MR. MONNINGER: This is John Monninger from the staff. I think one of the notions is, you know, we can do that, and those type of studies have been done in the past, but a lotta times, the way these studies are used or misrepresented is, you know, certain individuals or groups like to pinpoint and use data without putting it in the proper context, and we do not want to, you know, go down a path where a subset of information is misused and misrepresented. A subset of the data and results are out there.

So we think for purposes of this study, it is more appropriate to focus on the more frequent events, or events that may be expected, as opposed to things that are way out on the spectrum.

DR. APOSTOLAKIS: I would change the argument and argue the complete opposite, precisely because this is done because the previous studies have been misused. You have to be very careful, to make sure that what you present is real, in the sense that it is consistent with what the state of the art is.

It would be a disaster, I think, if you come out with very low numbers of current depths, say, and then somebody points out that it's because of the analytical method you use. Then why are we doing this? And I don't know that the 10 to the minus 6 sequence is more real than a 10 to the minus 9. Both of them are incredible to me.

DR. KRESS: It depends on how many 10 to the minus 9 sequences you have.

DR. APOSTOLAKIS: Exactly; exactly. That may be part of it.

DR. BONACA: Specified, if I remember, 10 to the minus 6 as a first step; right?

MR. PRATO: As our initial focus.

DR. BONACA: As our initial focus. But do not say that you should not go beyond that, the initial focus. And how do you interpret it in terms of this report? So you're going to go beyond that at a later time?

MR. PRATO: I don't know at this stage. I mean, it's too early to tell.

DR. BONACA: I think the point that George is making has merit, so I think that as you review, once you do this, you have to evaluate what it means to go beyond 10 to the minus 6, and see what the effect is.

DR. APOSTOLAKIS: Right.

MR. TINKLER: I have not read the study you refer to, but again, I believe that the thrust of that additional consideration by EPRI was to show that that residual risk, if you will, was very, very low, and so in order to buttress their arguments on the issue of completeness, they opted to do that additional calculation. But to the extent they demonstrated that residual risk is quite low, there would be no reason for us to believe that we would generate results that would be, in any way, different from that general concept.

I mean, the use of a cutoff, of a

threshold we believe is supported by such a conclusion, and as a last proffer on this, I would say that using values we are, we're selecting, are already a very small fraction of the safety goal. We're not excluding anything that would be, by definition, quite large. I mean, we're --

DR. APOSTOLAKIS: Yes. There's no question about it. That you will be below the goal.

MR. TINKLER: Okay.

DR. APOSTOLAKIS: They conclude the same thing.

MR. TINKLER: But if we do, if we go down many, many decades, simply to prove that point, how do we then communicate this in a way that is meaningful? And again, I would say -- I'm not disparaging EPRI's study, but going through the exercise of simply multiplying the numbers together doesn't mean you've got a better understanding of risk.

I mean, they can go through that exercise but you would have to -- I'm sure there are areas where you -- and if you start looking at the uncertainty of 10 to the minus 10, 10 to minus 12 events, I don't know where you would stop in that vortex.

DR. APOSTOLAKIS: You stop when the results are not sensitive to the cutoff frequency anymore. That's when you stop. That's what's usually done.

DR. KRESS: You're looking at process for selecting sequences. Don't we already have enough PRAs for the variety of plants, to know which sequences are likely to be the risk-dominant ones, even though we've got improvements in MACCS and MELCOR, that may change this, wouldn't that be a place to say we'll select the risk-dominant sequences for this type of reactor, based on existing PRAs, and not have a cutoff rate, just select those sequences that are risk-dominant from the standpoint of death?

MR. TINKLER: Absolutely, and we are very mindful of that, and I believe you'll hear more about our selection process, it does identify those sequences that have customarily --

[Simultaneous conversation]

DR. KRESS: Been the actual risk --

MR. TINKLER: -- in current PRA as risk important --

CHAIRMAN SHACK: But I mean risk and consequences are different. In your case, George,

you're never going to converge. If I keep going lower and lower, my consequences are probably going to keep going up and up.

DR. APOSTOLAKIS: No. They used all the sequences.

CHAIRMAN SHACK: Because they're multiplying the frequency times the consequences. Yes. The risk will come to an equilibrium but the consequences will probably just keep going up.

DR. APOSTOLAKIS: I don't understand why you say they multiply. They develop a risk curve. They don't multiply anything.

CHAIRMAN SHACK: That's like multiplying a frequency times a consequence.

DR. APOSTOLAKIS: It seems to me, you know, the issue is very simple. All I'm saying is consult with the study and see whether it's applicable. But it's very simple. I'm calculating the frequency of X and I have to make some approximations. I will try to make my approximations such that the sensitivity of X to the approximation becomes negligible.

Now if I want to calculate the frequency of X, but I use as a criterion of the approximation Y, which is a CDF, then I really don't know what

happens to X. That's really the point.

If you were calculating CDF, this would make perfect sense; but you're not. You're going way beyond. And to argue that a 10 to the minus 6 sequence can be explained to the public but a 10 to the minus 9 cannot, I don't think that's a valid argument. I would say neither one can be explained. They're both incredible.

MS. SHIU: This is Mike Shiu from the staff. I think we understand the 10 to the minus 6 sequences a lot better than we understand the 10 to the minus 9 sequences, and the uncertainties by which we would characterize the 10 to the minus type sequences are smaller than the 10 to the minus 9 type sequences.

So I think you know, if you want to go down at the 10 to the minus 9 level, we would be drawing in uncertainties that would be somewhat large.

DR. APOSTOLAKIS: These 10 to the minus 6 for CDF will become 10 to the minus 8 for risk. Won't it?

MR. SHIU: Right.

DR. APOSTOLAKIS: Because additional things must fail. So don't tell me 10 to the minus

6 we understand. This is just CDF. I have to fail the containment. I have to move with -- so this 10 to the minus 6 eventually will go down to minus 8 or 9.

MR. SHIU: But George, I think the bottom line is that I think we would think that the risk is small whether you go down to 10 to the minus 9 sequences or not, and as long as we couch the results of our study with the fact that we started looking at sequences at 10 to the minus 6 CDF level, for example, we have to clearly explain our boundary conditions for our study.

I think that the message to the public would not be skewed as long as we are clear as to what we are looking at.

DR. APOSTOLAKIS: The first objective was stated as determine best estimate, and what I'm saying is with this thing, you're not going to get a best estimate. That's all.

CHAIRMAN SHACK: Can we move on, George?

DR. APOSTOLAKIS: I think we can. I'm surprised by the resistance. I think it's obvious.

[Simultaneous conversation]

DR. APOSTOLAKIS: We should have more frequent meetings before things are cast in stone

and the staff is defending what they have done, to death. I don't know. But if I see this in the fall, I'm going to write additional comments, if the committee doesn't agree with me. Because this is not acceptable and I think Commissioner Jaczko, in his dissenting comments, talked about a complete picture of risk and that he disagree with the cutoff.

MR. NEROKA: If I can make one comment, because I don't want to leave this open-ended.

You know, there are several thoughts that went into what kind of criteria do we use for this consequence assessment. The nature of a more realistic assessment, and what areas you look at, what's more realistic as opposed to looking at everything possible?

I'm not saying that's, you know, right or wrong, but I'm just talking about -- these are kind of the thoughts that went into coming up with the threshold, initial threshold for screening, something that's more realistic, to start with, to get the consequence for those accidents and errors. So just --

DR. APOSTOLAKIS: I'm aware of what screening means, yes. I've done it many times

myself.

MR. PRATO: All right. External events. We identified the dominant external initiating event sequences, including seismic, flooding, fire, wind. Based on new Reg 1150, IPEEE submittals, external events, SPAR models and/or just general generic insights.

We used relevant generic insights to select representative sequences, to qualitatively assess the related risk for some events.

DR. KRESS: Will this include shutdown sequences?

MR. PRATO: Excuse me, sir?

DR. KRESS: Will the study include shutdown sequences?

MR. PRATO: No, sir; just operating. Okay. With regards to containment system states, the staff will identify the anticipated availability of containment systems and containment support systems, not considering the level 1 core damage analysis that can impact post-core damage, accident progression, containment failure and radionuclide release.

With regards to mitigative measures, for each sequence grouping within the scope of the site-

specific analysis, the staff performed procedural and system reviews to identify applicable, both implemented and committed to, in writing, mitigative measures that can potentially prevent or delay core damage, reactor coolant system failure and/or containment failure, and the approximate time for implementation after the initializing event for input into the MELCOR.

Structural analysis. The staff will perform a structural analysis to determine containment leak rates in terms of leakage versus pressure for reinforced, prestressed and/or steel containment structures that exist at each site within the scope of the survey analysis. We're going to have a specific presentation on that as well.

With regards to MELCOR, the last time we were here, we identified the MELCOR code improvements that we were going to implement. Those have been implemented. Jason will cover those in his presentation.

We are also developing a plant-specific model for each plant being analyzed, and then we will perform site-specific accident progression analysis for each plant, using MELCOR computer codes

to determine source term, potential containment failure states and time, and time of release for input into the MACCS2 analysis.

Emergency preparedness. A lot has been done in this area. We are modeling the protective response afforded by current site-specific emergency preparedness programs.

DR. APOSTOLAKIS: What does that mean? Are you going to have a special --

MR. PRATO: It's going to be site-specific. It's not --

DR. APOSTOLAKIS: There will be a presentation on this later?

MR. PRATO: That's correct, sir; in detail.

DR. APOSTOLAKIS: Okay.

MR. PRATO: Finally, MACCS2. Again, we have discussed the potential MACCS2 code improvements that we're going to be implementing. Those have been implemented and Jocelyn is going to cover each one of those during her presentation. We are developing a site-specific model for each plant being analyzed, based on meteorological data and emergency response parameters, and we're going to perform consequence analysis for each plant using

MACCS2 computer code to determine early fatalities and latent cancer fatality.

That covers the overview. Next, Richard Sherry from the staff will present accident sequence selection and containment system states.

MR. SHERRY: Next slide. This diagram is a little more detailed diagram of the process that we used to identify the sequence groups to analyze in the SOARCA process. I'm going to go into a little more detail on each of these blocks. I won't really discuss this slide right now. Next on.

CHAIRMAN SHACK: What's an enhanced SPAR? Is that a version 3.31 or is that an enhanced SPAR, an even more enhanced SPAR?

MR. SHERRY: That's the 3.31 models with cut-set level we use.

For the internal event-initiated sequences, we used both the plan-specific SPAR model that we have and insights from the plant PRA to identify the sequences.

We also then, once the sequences had been determined, we collected the sequences into groups based on similarity in the availability of frontline systems that impacted core damage, and on the timing of the sequences.

So now, at that point we're dealing with groups of sequences, and we went to frequencies well below the screening criteria at this point, okay, down to approximately 10 to the minus 8.

DR. BONACA: This SPAR version is the one that has the improved pump seal model?

MR. SHERRY: Yes.

DR. BONACA: That's the one you used at Surry?

MR. SHERRY: It has the Westinghouse Owners Group.

DR. BONACA: Yes. I saw that. Okay.

DR. CORRADINI: So let me -- I'm late but I'm sure you -- George already asked this, but just a short version of it. So between 10 to the minus 8 and 10 to minus 6, that is the sum of the CDF up to that point, excluding containment failure probabilities, but just to get to a core damage frequency?

MR. SHERRY: That is the core damage frequency; yes.

DR. CORRADINI: Okay. And similarities between sequences -- I guess I'd ask it differently. If I had path one -- I don't know about SPAR or any of this, but just if I had various paths, and then

at the very plants I branch to a different path, are they combined so that you're not, by subdividing, driving down the individual sequence number?

MR. SHERRY: Yes; that's the main purpose of the grouping.

DR. CORRADINI: Okay.

MR. SHERRY: So that we don't keep bifurcating until we eliminate all the sequences based on frequency of individual sequences, cause that wouldn't make any sense at all.

DR. CORRADINI: Okay. So what are some of the notable ones between 10 to the minus 8 and 10 to minus 6 that we'll be eliminating? Are there an notable ones?

MS. SHIU: I think we need to discuss those results in this afternoon's session.

DR. CORRADINI: Okay; fine. Thank you.

MR. SHERRY: Then once we have the sequence groups, we perform the screening analysis, and as Bob had mentioned, we used approximately 10 to the minus 6 to screen out sequence groups, essentially where the containment's intact, and for sequence groups where we believe the radionuclide release may be large or may be early, for example, for containment bypass sequences, but we screen at a

lower value of 10 to the minus 7 to capture those particularly important sequences.

The column on the right indicates our main results or outputs for this analysis, okay, and I won't go over those in detail.

Next slide, Bob.

For the external event analysis, the process was a little bit different. We used, to a greater extent, insights from prior analysis, in particular new Reg 1150, for both Peach Bottom and Surry. There was extensive external event analysis done for new Reg 1150.

We also used insights from the IPEEE and, where available, results from the SPAR external event modeling.

In addition, we went even beyond looking at plant-specific analysis, to consider insights from external event analysis on similar plant types.

Okay. And generally then we would come out with a recollection of here are the important sequences, external event sequences that had been found for either this plant in prior studies, or for this classic plant in prior studies, and then used that as our definition of the sequences to be considered for external events in the circuit, for

the circuit work. Okay, Bob.

Given that the NRC does not have SPAR models that continue from core damage out to the consideration of containment systems and containment phenomena, we're not able to essentially do a SPAR analysis or to take into account, or determine the availability of containment systems.

So what we did was a fairly simple approach, is to look at the availability of support systems by examining the important sequences and cut sets from the unscreened sequences, and then determine which support systems would be available, had not been felled.

And then look at the important containment systems, or the systems we believe are important for the containment acts and progression, and determine their availability based on the availability of the support systems. Okay.

In this case we are neglecting random failures and human errors associated with the containment systems, but we believe these, that fraction of the sequences, which would have additional random failures, or human errors causing the containment systems to fail, would give us, lead us to much lower frequency sequences than for the,

for successful operation of the containment systems, given that their support systems are available.

We also plan to have our analysis, our methods, our results looked at by additional groups besides the ACRS. As mentioned before, the SPAR model that we're using has already been subjected to a cut-set level review against the licensee's PRAs.

We are also going to have a internal Peer Review Panel meeting to review the sequence selection methods and results later this week.

DR. CORRADINI: So can I ask another question just for clarification? So let's take the interfacing LOCA with Surry. So let's say the interfacing LOCA with Surry, after all these years, still falls above 10 to the minus 6. So it stays, as a set of states, that one would then consider.

And then you essentially freeze, that is, no human actions that could create more errors, you freeze essentially the plant state and then ask the question, if I continue down this path, with station LOCA, interfacing LOCA, what would be the release? Have I got it approximately right?

MR. SHERRY: Well, there's an additional step. The sequences, as we pass them on for further analysis down the line, prior even to the MELCOR

analysis, the sequences will be looked at from the standard of can they be mitigated by using additional systems not considered in the PRA.

DR. CORRADINI: But active or available based on the plant state from the 10 to the minus whatever. From the state of the plant at that time. In other words, they were operational. Now what can they do to mitigate the accident?

MR. SHERRY: Well, there are additional mitigative systems.

DR. CORRADINI: Okay.

MR. SHERRY: You know, fire water pumps, things like that, which may not have been considered in the PRA, but which are available.

DR. CORRADINI: I got it.

MR. SHERRY: And Bob will address those in more detail.

DR. CORRADINI: So I've got it approximately right for an internal event. So let's take an external event. Let's take an earthquake that's beyond the design, base earthquake for building the plant but is possible around in that area, and is not really a superturbulent earthquake, I don't decimate the whole landscape, but just good enough to take out certain safety systems, and that

comes in with a frequency in that range again. Same thing, even though it's external, but same procedure.

That is, look at the landscape, what the plant damage state is, find out what things are working, what things aren't working, and then proceed just as you said.

MR. SHERRY: Right, but in this case, with respect to mitigative measure, we would look at their potential to use them in the context of having a large or medium earthquake.

DR. CORRADINI: Okay.

DR. APOSTOLAKIS: Now the human actions, the CDF sequences already contain recovery actions, so --

MR. SHERRY: That's correct.

DR. APOSTOLAKIS: -- there is some probability that they will not be effective. And after the CDF, you said that there are no more possibilities for human error; is that correct?

MR. SHERRY: What I said was when we were considering systems that were not considered in a determination of core damage -- okay -- for example, if containment spray was not important for determining whether or not core damage has occurred,

it was not modeled in the level 1, not considered.

DR. APOSTOLAKIS: Right.

MR. SHERRY: We would look at what systems are required for that system to operate, look at the support system table, determine from the cut section, the core damage, whether any of the support systems had been failed. Okay. And make a determination whether or not the containment spray system would be available, based on the availability of the support system.

DR. APOSTOLAKIS: You make the performance of the containment spray system consistent with what has happened in the sequence.

MR. SHERRY: Right.

DR. CORRADINI: But you don't account for the fact the operator may forget to turn it on or send it the wrong place or --

MR. SHERRY: That's right.

DR. APOSTOLAKIS: Additional human errors are not considered.

MR. SHERRY: Additional human errors or random failures in performance; no. Frontline system.

DR. APOSTOLAKIS: Or random failures.

MR. SHERRY: We don't have the model for

the system.

DR. APOSTOLAKIS: But that system will have some availability, or unavailability.

MR. SHERRY: But I'm --

DR. APOSTOLAKIS: So that includes random failures. Do you assume the system --

MR. SHERRY: Essentially we're assuming the system is perfect, if the support systems are available.

DR. APOSTOLAKIS: Ah. And why is that, Rick?

MR. SHERRY: The main answer to that is that we believe that the conditional probability that you would fail the system from random failures or human errors, is sufficiently low, that multiply them by the, essentially the frequency coming in, that to have that sequence with loss of the containment system due to random failures, or human errors, would push the frequency well below our screening threshold.

What we're saying is that it's much more likely that the sequence, that core damage sequence would have that system available.

DR. APOSTOLAKIS: Surely it's much more likely because the unavailabilities are low.

MR. SHERRY: Right.

DR. APOSTOLAKIS: But I mean, I'm still puzzled why you have to make that assumption. I mean, if you look at the level, they didn't do that.

MR. SHIU: Let me take a shot at answering his question.

DR. APOSTOLAKIS: Yes?

MR. SHIU: Yes. I think we would have reconsidered this assumption a little more if the sequences we're looking at -- for the sequences we're looking at, this matters. But as we'll discuss this afternoon, for the sequences that we'll be looking at, these assumptions does not play that much of a role in it.

It's an initial assumption we made, that we would have revisited, if it had made a difference.

DR. APOSTOLAKIS: But also you said, Rick, that you consider the unavailability of the sprays, you would multiply that by the frequency of the sequence up to core damage, and that would push the whole frequency below the cutoff.

Are you still maintaining the cutoff? I thought the cutoff level was used up to CDF. After that, you just go. So every time there is some

additional frequency, you multiply, say now I'm below 10 to the minus 6. You would not -- no, no, this is really --

[Simultaneous conversation]

DR. APOSTOLAKIS: Huh?

DR. CORRADINI: That isn't what you're doing.

DR. APOSTOLAKIS: That's what he said. He said that if I consider the unavailability of the sprays, 10 to the minus 2, and multiply by the frequency of the sequence that leads to the need for the sprays, I may end up with a frequency of 10 to the minus 8, which is below the cutoff --

DR. CORRADINI: And you've never analyzed that at all.

DR. APOSTOLAKIS: Yes, and that doesn't make sense to me. The cutoff was supposed to be used only up to CDF, not continually.

MR. SHERRY: But remember, the cutoff, as initially proposed, was at the release, and it was brought back to CDF essentially because of the screening, essentially based on the fact that the staff does not have models to extend out to essentially the release end point. Okay.

DR. APOSTOLAKIS: Yes, but I mean if it

was moved up in the CDF, then why do you keep the assumption that was based on the previous interpretation of the cutoff? Wouldn't it be very simple to just do what any PRA would do and say, you know, CDF, then I need this system because of some unavailability, multiply, and then you go?

In fact, this seems to me to be an assumption that may lead to significant overestimation of the risk; won't it? Because some very important protective actions are not accounted for. Yes. No.

MR. SHERRY: It's the other way around.

DR. APOSTOLAKIS: You say protective. No; it's perfect. So it's underestimation.

MR. SHERRY: Correct.

DR. APOSTOLAKIS: It's underestimation. And the tools are there to do it.

DR. CORRADINI: But he can only do it for equipment. He couldn't do it for all the things he said in the containment, that they have no way to estimate other than --

DR. APOSTOLAKIS: For other things I'm willing to do along, but I mean, for standard systems like containment spray, it seems to me -- doesn't SPAR have an unavailability --

DR. CORRADINI: So let me ask a different -- let's ask a different question. Then we'll stop bothering you for a while.

DR. APOSTOLAKIS: Well, you don't stop.

DR. CORRADINI: Is this -- are we talking about --

DR. APOSTOLAKIS: What's this "we"?

DR. CORRADINI: -- a really thin slice of the whole pie here? Or is this potentially a large slice?

MR. SHERRY: It's a thin slice, but to answer the question why don't we analyze this out to essentially release, we, NRC does not -- do not have models that consider containment systems right now, nor containment phenomenon.

DR. APOSTOLAKIS: How was 1150 done? 1150 was sponsored by the NRC, wasn't it?

MR. SHERRY: There are models, what are the sets in event tree, for a select set of plants.

DR. APOSTOLAKIS: But these two are part of the select group.

MR. SHERRY: That's correct.

DR. APOSTOLAKIS: So why can't you take the Sandia work that was done 20 years ago and use those?

MR. SHERRY: Well, then we would get 1150.

DR. APOSTOLAKIS: What's wrong with that?

MS. SHIU: George, I think to answer your question, we could actually have done the fault trees and extended our event trees, which is what we are actually doing to our SPAR models but we're not doing them at this stage.

We made the initial assumption that we will not consider equipment failures and had that assumption turned out to be important, we did consider them. If the assumption had turned out to be important in our results we would have reconsidered them, if the models we did -- but I think --

DR. CORRADINI: It's a small slice.

MR. SHIU: It's a small slice, to answer your question.

DR. APOSTOLAKIS: Why is it a small slice?

DR. ABDEL-KHALIK: You know, a big part of the outcome of this project is essentially public information, and therefore, anything that sort of casts down on, you know, the validity of the

results, or that the results may be biased, one way or the other, really defeats the ultimate purpose of the project.

DR. APOSTOLAKIS: Precisely my point, Said. Thank you.

MR. TINKLER: I feel obliged to say again that we understand these issues, and in the preparation of the public report, we will lay out the arguments for why we have taken the approach we have taken. We're basically having the same argument again over the threshold. We now are folding in containment systems as part of the threshold. We meant to make clear that that was always the case. It's just for what we call screening purposes, we opt for the CDF because it was a metric that was available to us.

But if you look at the pies, as in new Reg 1150 --

DR. CORRADINI: And that's why I use the word pie.

MR. TINKLER: -- those additional random failures, coupled on top of other random failures for core cooling, would never show up large, and as Mike has said, most of this discussion -- and we'll make that more clear in the afternoon -

- because of where we end up on sequences.

DR. CORRADINI: Okay. So we'll have to see in the --

CHAIRMAN SHACK: We're going to have to move on here a little bit, we're on the second presentation here and we've got a long way to go.

MR. PRATO: Okay. Next is going to be on MELCOR. Jason Schaperow will present that information. Jason.

MR. SCHAPEROW: Thanks. In an effort to improve the realism of our severe accident analyses, we've continued to make improvements to the MELCOR code, which is our primary severe accident model.

We've made several improvements over the last few years. I'll talk about a few of them.

In the area of fission product release and deposition, we've done some benchmarking of our CORSOR-Booth model, which is currently our model for release of fission products from the fuel.

DR. KRESS: Does that include a consideration of burn-off or is it just sort of an average? Because some of the VERCORS tests went to high burn.

MR. SCHAPEROW: Yes. I think it's meant to cover that, the higher burn-offs; but I'm not

sure. I can get back to you on it.

We benchmarked against PHEBUS and VERCORS tests. One of the outcomes of the PHEBUS test was that it was decided that the cesium volatility should be based on vapor pressure of cesium molybdate, which is a lower vapor pressure than we had assumed in the past for cesium.

Our MELCOR modeling includes a nonradioactive aerosol release from silver-indium-cadmium control rods, and tin from zircaloy, another nonradioactive aerosol, and the purpose of these additional aerosol releases is to have a more realistic aerosol deposition model because these things will tend to promote additional deposition by having more aerosols beyond this fission product aerosol.

Another improvement we've made is to explicitly account for mechanisms for relief valve seizure, both on the primary side and the secondary side for PWR.

Two seizure mechanisms. One mechanism that we model is the number of cycles. When you hit a set number of cycles, on the order of a 100 cycles, we would assume the valve sticks open and seizes in the open position and can therefore be

depressurized in the system.

The second mechanism we consider is high temperature. Once you start melting the core, you get very superheated steam and that superheated steam passing through the valve can also stick it open.

We've made improvements in modeling in-vessel debris behavior. With the release of MELCOR 186, we do now have the capability to model molten cool formation in the core region, looking like a TMI type accident, with possible crust formation, and the modeling that we're doing is in fact guided by our ongoing TMI assessment with MELCOR.

DR. KRESS: Does that molten cool modeling include fission product release from the molten cool?

MR. SCHAPEROW: I believe the fission products, the volatiles devices will be released before it gets to that stage. I don't know.

DR. KRESS: It was my impression, though, that the experimental data indicated -- I can't remember the name of the experiment -- but the experiment indicated that, by the very fact you leave it in there longer, you're actually releasing stuff during the pool process, I would expect.

MR. SCHAPEROW: Lower volatiles, you would. I think the volatiles would pretty much be released by the time he got to a pool state. The modeling should reflect that.

DR. KRESS: But you're moving the -- okay.

MR. SCHAPEROW: We also have modeling of the molten pool. If the side crust breaks, it can go down into the region between the shroud and the core barrel. Again a la TMI.

We also have more detailed representation of material relocated to the lower plenum, and at the bottom head itself.

With regard to our BWR model for Peach Bottom, we now are using geometry and material composition for the current 10 by 10 field design, which is of course different from the old design, more rods, thinner rods, thinner clay. Our model does include this now.

We've developed new estimates of decay power and fission product inventory for mid cycle, managed cycle. We're also using spatial distribution of decay power, fission product inventory, based on axial and radio power data for several recent cycles. So again, we're trying to be

more realistic, best estimate, reflect what is in the plant, what the plant is now doing.

We've implemented our fine description of the reactor upper internals, in particular the moisture separators and steam dryers. We're trying to have more realistic representation of radionuclide deposition in that area.

I also want to represent there the heat sinks in that area cause this can influence the advection to the steam line nozzles and potential for creep rupture of the steam line, and also the potential for the sticking open of the relief valve on high temperature.

We've also improved our MELCOR model for Surry.

We've made improvements to our modeling of the reactor coolant system at high pressure with the core uncovered. I imagine the committee's heard a lot in this area on SCDAP/RELAP analysis for steam generator tube integrity. The improvements we've made at MELCOR do come out of that ongoing effort with SCDAP/RELAP5 and CFD in that area, which we're trying to learn from what they've done and try to reflect that in the MELCOR model.

In the area of natural circulation, we

do now have steam-to-wall radiation in all parts of the Reactor Coolant System. Another recent improvement to MELCOR --

CHAIRMAN SHACK: Jason.

MR. SCHAPEROW: Yes.

CHAIRMAN SHACK: For example, I mean, you would then get credit for depressurization from failure of the hot leg from those analyses? Is that the sort of thing that happens with that kind of model?

MR. SCHAPEROW: That's right. Through the recirculation of steam through the system, we can either get a relief valve sticking open, we can get the creep rupture of the hot leg and the hot leg nozzle. We could get failure of the tube, assuming again it stays at high pressure, which I'll talk about a little alter.

DR. CORRADINI: So -- well, I guess that -- okay. So you're going to talk about it later. I guess I'm back to the pie slice question, which is this all sounds good if you somehow find your way into this region of reality, but with mitigating -- with severe -- or emergency actions, operational actions, I thought now all plants are supposed to depressurize much sooner into the game.

MR. SCHAPEROW: Well, we'll talk about that, in detail, this afternoon, when we go over specific scenarios for these plants.

DR. CORRADINI: Okay.

MR. SCHAPEROW: If we can wait till then.

DR. CORRADINI: Sure.

MR. SCHAPEROW: A recent improvement to the MELCOR model is heat loss from the reactor and coolant system and containment. Two megawatts of heat is one of the systems of temperature and this is going to be significant as I point out here on the slide. At ten hours, decay power is about 20 megawatts for this plant. So it's about 10 percent of the power.

We've adjusted the hot leg natural circulation rate to match the observations from our recent CFD analysis.

We're now using the hot leg-to-tube recirculation ratio of two and in the plenum mixing fraction of 85 percent, again consistent with the SCDAP/RELAP five work.

And another modeling we've currently made to MELCOR was to model individual pressurizer relief valves. Before we had a lumped valve, we had

one valve that represented the flow area of all the valves combined. So now we've separated that into individual valves. So one valve will open up first, relieve the pressure and then close. It won't get -- it'll be a little different response.

But again, our intention is more realistic.

Regarding pump seal leakage modeling, this is an important area. We've used the insights from the SCDAP/RELAP effort to improve the seal leakage location and got this to be more realistic.

We also have a simplified leakage model to represent the leakage past the seal package and also the failure of the seal package, and we've benchmarked this against the more detailed models by the ACL and Westinghouse, and it compares well.

With regard to creep rupture model, we now have a separate section of how leg piping corresponding to the nozzle, which is I think about ten inches long, of carbon steel, and of course we have the stainless steel hot leg segments that we always have.

Again this is to do a better representation of a creep rupture, if it occurs.

We also now have a more accurate stress formulation for predicting creep rupture.

Previously, we used a simple thin wall model.

Okay.

MR. PRATO: Okay. Next is the emergency preparedness. Randy Sullivan is out of town, so Joe Jones from Sandia National Labs is going to give us his presentation.

Joe.

MR. JONES: Let me make sure these slides are the same as the ones I have. Yes.

For the SOARCA project, we're going to be modeling EP. Modeling the emergency preparedness and emergency response afforded by NPP Preparedness Program, substantially improves the realism. We'll be considering site-specific EP programs, such as the activities the state will be taking, and public response.

All NPPs have regularly inspected and exercised EP programs, and the modeling will realistically represent the NRC defense in depth policy, by taking into account the plants and resources that are in place just for this purpose.

DR. BONACA: What do you mean regarding this?

MR. JONES: What's that?

DR. BONACA: When I read the statement, represent NRC defense in depth policy, I also think of any scenarios that you want to bound, irrespective of the frequency of the scenario?

MR. JONES: Correct.

DR. BONACA: I understand.

MR. JONES: To model EP, we must make some assumptions, and some of these appear obvious but these are frequently challenged, so we're just putting them up front. Officials will implement the emergency response plan. The public will largely obey direction from officials.

DR. APOSTOLAKIS: Is there any evidence of that?

MR. JONES: Yes, there is. Let me get to the last bullet, the second -- the next one is emergency workers will implement the plan. Those middle two bullets are frequently challenged, and we did a study for the NRC, a couple of years ago now, it was published in January of 2005, in the last bullet here, identification and analysis of factors affecting emergency evacuations.

And we looked at over 200 evacuations and studied fifty of them, in depth, and we more recently studied Hurricane Katrina, Hurricane Rita,

and some others in the last couple of year, and quite honestly, the public, very largely, obeys the direction from officials.

DR. APOSTOLAKIS: So in Katrina, the officials implemented emergency plans?

MR. JONES: Yes, and their plans were failed. They had very poor plans. In New Orleans, for instance, they had no bussing plan to bus people that did not have vehicles out of the city. People --

DR. APOSTOLAKIS: I thought the whole controversy is that they did not implement --

MR. JONES: No, they did.

DR. APOSTOLAKIS: -- in a timely fashion.

MR. JONES: Well, they didn't order a mandatory evacuation in a timely manner.

DR. APOSTOLAKIS: Which is --

MR. JONES: The key word there is mandatory. But it wouldn't really have mattered. They had no way to get the people out.

DR. APOSTOLAKIS: But that is irrelevant.

MR. JONES: Well --

DR. APOSTOLAKIS: It turned out that it

wouldn't have mattered, but I mean, if you say the public is expected to obey direction, and that direction doesn't come --

MR. JONES: In Hurricane Katrina, specifically, the evacuation is considered successful. The people that had vehicles and wanted to leave were able to leave and left.

DR. APOSTOLAKIS: I don't understand this. I mean, why can't I use the same argument and say during the level 1 PRA, our operators are well-trained, they have emergency procedures, they will do the right thing? We were saying that before TMI, until we realized that we have to include the probability of error.

So why can't I say that in level 1 PRA and I can say it here? I mean, it seems that the assumptions are to optimistic.

MR. JONES: Well, we're not stating that a 100 percent of the public -- and I'm sure we'll discuss this this afternoon -- will evacuate. B ut they generally follow the rules -- the orders of public officials.

DR. CORRADINI: I'm sure we've got 6864 and I'm sure I'm supposed to have read it. But assuming that I forgot it, I would expect that the

three bullets above are a function of scale. that is, the larger the accident, the lower the probability it all goes well, and the smaller the accident, the higher the probability it all goes well.

Did 6864 see anything relative to scale of the event, relative to failure of those -- not failure of those bullets -- the ability to have fidelity in those three bullets?

I mean, that's the way I was thinking of it. As things get more gargantuan, all hell breaks loose.

MR. JONES: That's correct, but when you look at, for instance, bullet two, the public is expected to obey direction from officials, it's a very small percentage in a small accident that does not obey, and it's a very small percentage in a large accident --

DR. CORRADINI: Really?

MR. JONES: -- in a large evacuation, that does not obey.

DR. BONACA: I think Katrina is really uniquely ... nuclear power plant in the sense of a large, you know, population, a huge population to be evacuated under conditions of non-preparation.

Typically, at sites, you have very elaborate plans there with very capillary information going in, you have town meetings and people discussing what they will do in this event of an event. So there is significant amount of training -- sirens, communication means, and other kind of stuff, which is different. So I mean, that's probably the kind of information you sampled.

MR. JONES: Yes.

DR. APOSTOLAKIS: In our research report, we should advise the Commission to counsel or research on human errors.

DR. BONACA: But people are always well-trained.

DR. MAYNARD: But I think they're doing the same thing here that we do with PRA part procedures and stuff. We generally say that operators are well-trained and generally do the right thing, but they don't always.

DR. APOSTOLAKIS: Exactly.

DR. MAYNARD: I think they're saying the same thing in emergency evacuation. That in general, the public's going to obey the officials but not in all cases.

[Simultaneous conversation]

MR. JONES: Not in all cases, and we will account for that and you'll see that this afternoon.

DR. APOSTOLAKIS: So there will be some -- the officials will implement, you will account -- well, we'll see this afternoon.

DR. MAYNARD: But I think that another, a key aspect of this compared to some of the, like Katrina and stuff, nuclear power plants, they have their own plants that are exercised with the state and local agencies. They already have public transportation arranged for their areas, and also, all of the exercises go clear to the biggest event.

So it's not like you only exercise at a small event and that something big would change it. I think it'd be applicable, whether you're talking a large event or a small event.

DR. BONACA: I think what happens too is that you have, again, this capillary, and you have organizations supporting, outside organizations, they are really vying to having the equipment, for example, the radios, the sirens and other kind a stuff, and they really are committed, the emergency workers, they're really, from what I've seen, a very committed crew.

I mean, they really are competent and ready. So now they make -- they may make a mistake. There may be, you know, a breakdown in communications somewhere, but, in general, that's a proper statement.

DR. MAYNARD: But they do take into account some percent of breakdown in the --

DR. CORRADINI: It's a matter of course. But I guess I want to get back to the scale. You answered my question and I guess I've got to read the report now, because it kind a surprised me. So you're saying the percentage of those that say, ah, the hell with it, I'll do what I want -- that percentage is not a function of scale?

MR. JONES: With the exception of hurricanes.

DR. CORRADINI: Well, now I'll get to my second -- my second attribute is manmade events versus natural events, and I'm very curious about how behavior of obeying one, two and three are, whether I have manmade versus natural.

MR. JONES: When you look at manmade -- and you can also include wildfires as well as floods -- people will typically follow -- you'll still have noncompliance. Even in Apex, North Carolina, last

year, a huge chemical fire, a huge plume, evacuated 17,000 people. There were still some people that said I'm not leaving; not a large percentage but some. So real hazard, people staying behind. A small percentage. And those will be accounted for.

Hurricanes, you have the mindset of -- until Katrina -- you had the mindset of -- and this is why many elderly people died in Mississippi and in Louisiana. I lived through Camille, I lived through Betsy. Can't be that bad.

Well, in reality, it wasn't. It was the levees breaching and the flooding, and post -- you know -- not being able to get them out, that caused many of the casualties.

But that's one mindset associated with hurricanes that you do not typically get with other natural disasters or manmade disasters.

DR. KRESS: Do any of the sites considering sheltering in place as part of their EP?

MR. JONES: Most all of the sites consider it and have it in EP as an option.

DR. KRESS: That's where I would think the second bullet might break down because, you know, you tell me there's going to be a nuclear power accident, and I want you to stay home, and say

I'm going to get the hell outta there. So is a lotta people. So is that part of the modeling?

MR. JONES: Well, you'll hear a lot more on that on Thursday. That really was looked at in the protective action recommendations project. But it's definitely an element. I doubt that it's something we'll be using with this project because of the source term.

DR. CORRADINI: But just to repeat. So you said manmade and natural are about the same if you take hurricanes out of the mix --

MR. JONES: Yes.

DR. CORRADINI: -- in terms of following directions?

MR. JONES: Following directions.

DR. CORRADINI: And the amounts are small, and the noncompliance is figured into the calculation?

MR. JONES: Yes.

DR. APOSTOLAKIS: Okay.

MR. JONES: Next slide. Now WinMACCS is where we integrate the modifications or the EP modeling.

DR. BONACA: I had a question there.

MR. JONES: Yes.

DR. BONACA: You said you will talk about it more this afternoon and Thursday. Forgetting the first study, I mean you still believe, or you argue that people will, in general, follow direction, even though sheltering, locally?

MR. JONES: We do argue that. I mean, there will always be a small percentage of the public that is just not going to do what you tell them to do. Some of the people that are not complying are people that are evacuating when they're told to shelter. Other people are people that staying behind when they're told to evacuate. There's always a small percentage, so --

DR. BONACA: There's an uncertainty there.

MR. JONES: There is an uncertainty there.

DR. MAYNARD: There's also a group that, like schools, the hospitals, and stuff like that, that the sheltering, they -- that's generally controlled by the local authorities, so they would be complying with that better.

The individuals in houses, you may or may not be able to control but --

MR. JONES: Correct, depending on the

timing of the accident, the state mandates what happens with school children.

DR. MAYNARD: Yes.

MR. JONES: And that's one of the things where WinMACCS allows now up to 20 cohorts and for Peach Bottom we'll be using six cohorts. We'll be using a non-evacuation cohort. Well, let me explain what a cohort is.

DR. CORRADINI: I was going to say, it's like a lump of people, I assume.

MR. JONES: A cohort is a population group that acts -- it has two kind of parameters to it. One, it acts differently than other population groups It must be able to be quantified and it must respond distinctly different than another population group. So that way we can track these groups of population. For Peach Bottom we have the non-evacuating cohort, people that stay behind. We'll have schools. We'll have special facilities.

We'll have a shadow evacuation that we're treating as a cohort, and then for the public, we look at the general public and we look at what we call the tail of the public, because the last 10 percent of the public seem to take an awful lot longer to leave than the first 90 percent, and we

don't want to skew our results by treating them all the same.

DR. KRESS: You have to specify the percentage of the population of each of these cohorts --

MR. JONES: Correct.

DR. KRESS: -- that you input?

MR. JONES: Correct. And that information -- for the SOARCA project, we're going out to 20 miles for EP. For the zero to 10 mile EPZ, we're taking our information from the licensee. It is information provided in their evacuation time estimation and in their response protocols.

In WinMACCS, each cohort can change speed up to three times, so this helps us be more realistic. We're actually modeling the transportation, so we know that, for instance, at the beginning of evacuation the speed is pretty good. Fairly quickly, it becomes bottlenecked and then towards the end it speeds up again.

DR. APOSTOLAKIS: What's the time scale here? How many hours are you looking at?

MR. JONES: That will be dependent on the source term and we'll be getting into that this afternoon.

This allow the roadway network, the WinMACCS revisions allow the roadway network to be modeled, so we can actually approximate the routing of the evacuees, which helps.

And then WinMACCS allows evacuation speed to be changed in any grid element, which lets us model the freeways, model congestion points, and the way that our evacuation model spits out results, we can quickly see where we have congested areas and where we have free flow and input that into the WinMACCS.

Now this afternoon, I just want to emphasize this afternoon, that we don't have a source term yet that we're working with on the EP side. So the values you'll see this afternoon are all kind a template values. We're populating our programs, getting ready to input real values when we receive the source term and understand it.

So, you know, be aware of that. I'll emphasize that again this afternoon. Don't take those numbers to heart at this point in time.

DR. KRESS: In the event of an external event, earthquake, does that change your modeling assumptions?

MR. JONES: No, it doesn't change our

assumptions, and I don't know if we want to discuss that this morning or this afternoon.

MR. PRATO: Can we leave that --

DR. KRESS: We can. Yes. I'll be happy to.

MR. PRATO: Okay. Finally, Jocelyn will present the next two.

MS. MITCHELL: Thank you. I have a laundry list on several slides of changes that we've made in the MACCS program. We have implemented user-friendly interface, which has been referred to. We call it WinAMCCS. So that it makes it a lot easier for folks to input -- tells the user what is necessary and what the values can be.

We've improved memory management. It turns out that the original part of MACCS were left over from the days of the reactor safety study and so we've sped up the calculation quite a bit by doing a lot of memory management.

You've heard already about 20 cohorts versus three for the evacuation.

The network evacuation model, most people don't realize, has actually been in the code for more or less ten years, but it was so user-unfriendly, that I don't know of anybody who ever

used it.

So what we have done is actually enabled the model, the model was always there, but we just enabled it, and I have a special slide on that a little bit later.

You also heard about evacuation speed change for grid elements, but we also can change it for preoccupation. If MACCS is using an hour of meteorological information that has precipitation, you can put in a multiplicative factor for all speeds, that will change the evacuation speed during the time when that information is being used.

We have added alternative model for latent cancer dose response, and you'll hear more about this later this afternoon.

Then the next slide, we have enabled a different plume rise model, and just to confuse everything, the new MACCS model is actually an older Briggs model. We've left the original one there but we've allowed the user to choose this older Briggs model.

For cases where you're using one hour of release and 16 compass directions, we have enabled the plume meander model, which is in Red Guide 1.145, that is, plume meander is a function of the

meteorological conditions, the stability class, wind speed, and also a function of distance.

The previous plume meander model was solely a function of the release duration. We have enabled potassium iodine ingestion model. We've enabled a long-range lateral plume spread model, used to be a function of distance downwind, that model still remains, but we have added one that is a function of time since the release.

We have enabled more compass directions. Sixteen was actually hard-wired into the code, and we now would allow more compass directions, 32, 64, as the user would want.

We've allowed more plume segments to model a release. It used to be four, subsequently was changed to ten, is now increased to fifty.

We've enabled shorter-than-one hour time intervals in meteorological file. If you choose more compass directions, or shorter than one hour time intervals, then the code knows that you don't need a plume meander model, so it doesn't allow you to choose one.

One of the big improvements is that we can, in a user-friendly fashion, enable parameter uncertainty to be assessed. The meteorological

uncertainty was always enabled from the days of the reactor safety study, that is, you could sample from the weather, and we still have that. That is the way we would intend to do this.

The source term would be repeated use of equally likely samples from MELCOR, so that you could run MELCOR and say use limited Latin Hypercube sampling for parameters of interest in source term uncertainty in MELCOR, and then ingest all of those and use them in a repetitive fashion.

For others, we would have ranges of values and degrees of belief for floating point variables that you could put in, and then you would have Latin Hypercube sampling and run repetitive MAX calculations and then coalesce all the answers in the end.

DR. CORRADINI: So can I just say back what you said. I don't think I really get it. But are you saying that you have an uncertainty analysis procedure, that once you have a release, you can fuzz up what is your point estimate?

MS. MITCHELL: Yes.

DR. CORRADINI: Okay.

MS. MITCHELL: Yes.

DR. CORRADINI: And that's both in

weather as well as source term?

MS. MITCHELL: Weather, source term, and other things. For instance, the dry deposition velocity. You could put that in as uncertain parameters.

DR. CORRADINI: Okay.

MS. MITCHELL: Okay? Ranges of values and degrees of belief.

DR. MAYNARD: In general, I take it there is some guidance or training for the people running this, to where if two or three different analysts were to run the same problem, you would expect to get similar results, or can you get a wide variance, depending on who chooses which models to run?

MS. MITCHELL: I think you could probably get a wide variance. We will make sure that the folks who are doing it know how we choose to implement best practices.

DR. CORRADINI: Let me ask a different questions along that line. So if I had a chemical release at my local dioxin plant, or if I had any sort of chemical release, so they have the same sort of predictive capabilities? Or is this far and away different than any other sort of industry in sort of

off-site predictive capabilities? In other words, if I took away the source term part and I said his question about meteorological approaches to an effluent that could harm me, is this typical of what we'd see or is this very atypical to the level of precision?

MS. MITCHELL: I don't know what chemical factories do. A lot of times they haven't had emergency plans. If you look at Waterford, for instance, was built where it's built because there's a whole bunch of chemical factories, and they had no emergency plans, no emergency preparedness at all, and when they had a release, they actually blew the dust off Waterford's emergency plans and executed them.

So I'm not sure that chemical factories do this kind of thing.

DR. CORRADINI: I'm more interested about the meteorological, not the source or the source

DR. APOSTOLAKIS: You mean the dispersal.

DR. CORRADINI: The dispersal of something. That it doesn't have to be meteorological.

DR. APOSTOLAKIS: It does have to be sophisticated. That when it comes to dispersion of plumes, yes, they are pretty sophisticated. I don't know that they are better than this --

DR. CORRADINI: Well, that was going to be my next question, is from a -- you answered with this laundry list of improvements and I'm trying to get a feeling for, Are we better? Are we worse? than something. And the only something I come up with is chemical plants and how they model their off-site dispersion of their effluents.

So I'm curious, have you checked --

MS. MITCHELL: Are you talking about routine releases in the effluents? The effluents are really tracked with EPA codes, so they would use a year of meteorological data, several years of meteorological data.

DR. CORRADINI: I see. And these techniques are similar to what EPA is doing?

MS. MITCHELL: Yes and no. I think that EPA is looking at something that is going on on a constant kind of basis. I think that they tend to consider changes in the chemical. I release a certain chemical, and then, if the sun is shining, it may change to another chemical, and so they may

model a lot of chemical changes in the atmosphere which we don't model at all.

DR. KRESS: There's a difference in my mind between a code like MACCS2, to predict the sort of risk profile, as opposed to what you'd use in an actual accident. You want to track a plume and have some sort of emergency plan that relates to what was ongoing at the time. So you might use a different kind of -- for that.

MS. MITCHELL: For emergency decision, the NRC would use a code called RASCAL --

DR. KRESS: Yes, and which is different than --

MS. MITCHELL: -- which calculates the EPA guideline, which is a four day groundshine, in order to avoid a dose that you would get with a four day groundshine, you would recommend an emergency response. So that code is a different code.

If you really had an accident and you wanted to evaluate after the fact, what is the consequence from that particular accident, you have other considerations. You will have data, you will actually have measurements off site of deposition of radionuclides and you would have to have a process that would ingest that data.

DR. CORRADINI: Right, but I guess I would, to get to Tom's point, I guess I assume -- I don't remember the name of it, I guess it is RASCAL -- whatever these wonderful names are -- and I assume this is a simplified version of it, to run multiple cases many times, but it would have the same general physics.

MS. MITCHELL: RASCAL actually is a Gaussian puff model. MAX is a Gaussian plume model, and we ran a set of comparative calculations between what is the state of the art in 3D models, at a site. We used the Lawrence Livermore National Laboratory LODI ADAPT code. We compared the RASCAl code and we compared MAX code on yearly average expectation type values, which is what you want for this kind of a code.

And I wouldn't suggest using MAX to compare for one real release on one real day. You would use something like LODI ADAPT. But we found that for the year average, the expectation value for ground deposition and for concentration in the air, out to a 100 miles from the site, that there was very little difference between those. That was something that was reviewed by this committee in rather detailed --

DR. KRESS: Yes. We gave you high marks for that study as best I remember.

MS. MITCHELL: Yes; yes, you did. Thank you very much.

DR. KRESS: On your third sub bullet plan --

MS. MITCHELL: Yes?

MR. NEROKA: -- is that left up to the user, to decide on those ranges and degrees of belief? Or it there something built into the code already --

MS. MITCHELL: No, it's a user input.

DR. KRESS: User input?

MS. MITCHELL: We will have guidance, let me say, if you wait two more slides or three more slides, we'll get to that particular point.

You might want to see a picture. This is the screen that would come up, that would enable the network evacuation model, and so you could take a little arrow in each of these particular grid elements and you could indicate by that arrow which way the folks that are in that block, in that grid element, would actually evacuate.

Previously, you would assume that the people in this box would just go directly downwind,

but this allows you to model, that there is a road network out here, that would send folks around in the different direction.

So that if you wanted, you could put a radius in kilometers, and you could have a sector. Here's 16 sectors around this direction, and you could put a speed multiplier that would apply to that grid element, that would allow for freeways or cities or something like that.

I do want to point out that here's a little button, that if you wanted to make something uncertain, that you could click this button ad it would allow you to make things uncertain.

CHAIRMAN SHACK: You have MACCS models like this for different sites as a standard package?

MS. MITCHELL: It would certainly be site-specific, and for the sites that we evaluate, we will have such a thing. But it is definitely site-specific. The way the roads are is massively site-specific.

CHAIRMAN SHACK: Okay, but then you don't have -- that's something that you have to develop.

DR. CORRADINI: That's to be developed.

MS. MITCHELL: For all the sites that we

do, it will be developed.

DR. KRESS: There's already information on the roads and the population --

MS. MITCHELL: We get a map. This map is --

DR. KRESS: You'll get a map --

MS. MITCHELL: Yes. So the --

DR. KRESS: And you'll superimpose that on this grid.

MS. MITCHELL: Right. So the user would actually choose these radii, okay, and the compass directions, always centered on north. If you had 32, it would still be, the first one would still be centered on north, but they would be numbered around in here. But you'd choose the radius and then ask for the map to come up below it, so that you can actually see --

DR. MAYNARD: So you will be doing at least one of these for each of the, what is it? a minimum of eight plants that you're going to do?

MS. MITCHELL: Maximum of eight plants.

DR. MAYNARD: Maximum of eight.

DR. KRESS: So you would have time for the evacuation of the folks in a grid location, and roads, and the population in that grid? Or is there

some --

MS. MITCHELL: The sites, all sites have an evacuation time estimate, which they have prepared for their own site, based on road conditions, numbers of people, anything else, the time of the day, Sundays may be different from weekdays, precipitation may make a different time estimate. So all sites have those, and the folks who are putting these numbers in are actually using those estimates. Okay?

This is not strictly a change in MAX capability but we have, based on some comments that we received from folks who looked at what we were doing, and make suggestions for improvement, that we should update our dose conversion factor file to the newest information. So we have created a dose conversion factor file based on Federal Guidance Report 13, which attempts to implement the ICRP Publication 68 and 72.

Those are for internal, Federal Guidance Report 13 is for internal doses. Cloudshine and groundshine, which are external doses are based on Federal Guidance Report 12.

But we have enabled 50 files, 51 files, actually. 50 of them are one year, the first year,

the second year, the third year, all the way through 50th year of dose commitment, and the 51st one is for integrated value for the 50 year dose commitment.

For input values other than site-specific. Site-specific is all of the emergency response parameters, all of the source term issues. We have looked at a U.S. commission of a European Community study that was done in the 1990's called Probabalistic Accident Consequence Uncertainty Analysis.

In that set of studies, they elicited experts in different scientific disciplines, to find out what they thought were the ranges of values and degrees of belief for parameters which they believed were of importance, other than site-specific parameters, of importance in calculating the off-site consequences.

So they had six different groups, atmospheric science, radioecology, metabolism, dosimetry, radiobiology, and economics.

We have looked at the more or less 130 some odd different values that they were elicited on, and we have produced for them ranges of values and degrees of belief. So they would be available

if somebody could look at them, see how we evaluated the expert values that were elicited, and how we produced those ranges of values and degrees of belief, so they could agree with it or disagree with it as they wanted.

For SOARCA, in general, we will use the 50th percentile of the distribution as our point estimate for those values where we have a single point estimate.

DR. APOSTOLAKIS: My understanding of the -- but did these guys achieve a consensus --

MS. MITCHELL: No.

DR. APOSTOLAKIS: -- because I remember there was disagreement between the Europeans and the Americans.

MS. MITCHELL: They had normally eight experts and they were elicited separately, and they had their opinions, whatever they were they were, and we have taken each one --

DR. APOSTOLAKIS: I see, because the disagreement was on how to process the expert opinions.

MS. MITCHELL: Oh, we processed them, assuming that each one is equally likely.

DR. APOSTOLAKIS: I see. Okay.

DR. KRESS: What economic parameters are non-site specific? Things like the cost of a death or cost of an injury, or something like that?

MS. MITCHELL: We probably will not be using most of them. This is exactly what the study was.

DR. KRESS: You know, I'm interested in pricing you can get for economics, even though you say you're not going there.

DR. CORRADINI: So most of these aren't used?

MS. MITCHELL: No; no. The atmospheric science we will be using --

DR. CORRADINI: Okay.

MS. MITCHELL: Okay.

DR. CORRADINI: I misunderstood. So there's a large percentage that are not site-specific but are still --

MS. MITCHELL: These are all considered not site-specific.

DR. CORRADINI: I see.

MS. MITCHELL: They didn't look at, for this US/CEC study, any parameter that is of importance in consequence assessment that they believed was site-specific.

DR. CORRADINI: Right. Thank you.

MS. MITCHELL: So these are the dry deposition velocity, the wet deposition velocity.

DR. CORRADINI: Okay; got it.

MS. MITCHELL: The lateral plumes. You know, all of that stuff.

DR. KRESS: Are you still using the linear no-threshold?

MS. MITCHELL: We'll discuss that this afternoon.

DR. KRESS: Okay.

DR. ARMIJO: These 50 dose commitment files, are these done for different cohorts or are they done --

MS. MITCHELL: No. This is --

DR. ARMIJO: -- for the population at large?

MS. MITCHELL: This is Sieverts per Becherel, for a particular organ, for a particular radionuclide.

DR. ARMIJO: So they're not done for different groups of people?

MS. MITCHELL: They are from ICRP Publication 68 and 72. I don't know whether we have anybody -- maybe this afternoon, we should have some

of the health physics people. They may very well be adult values. We'll find out for this afternoon.

DR. ARMIJO: Thank you.

DR. KRESS: Is this like a TED:E?

MS. MITCHELL: This is Sieverts per Becherel of a given radionuclide for a given organ.

DR. KRESS: That can be --

MS. MITCHELL: For a given pathway --

DR. KRESS: Can like a TEDE be backed out of that?

MS. MITCHELL: TEDE. TEDE is a weighted value, so you would rate the lung by one value and the breast by another value, and so forth.

DR. KRESS: Can you weight reach radionuclide the same way?

MS. MITCHELL: The dose is the dose. So when you're getting a TEDE, it's a dose. You've got doses from all of the radionuclides to this particular organ. It is weighted by the tissue-weighting factor and produces a whole body TEDE.

DR. CORRADINI: So one of these is not a whole body calculation.

MS. MITCHELL: It's an organ.

DR. CORRADINI: Right.

MS. MITCHELL: These are --

DR. CORRADINI: All organ dose conversion.

MS. MITCHELL: By organ, by radionuclide, in this case by year, so if you ingest it, it will express itself by this many Sieverts per Becherel in year 27.

DR. CORRADINI: Got it.

MR. PRATO: That's the end of our presentation this morning. Do you have any questions?

CHAIRMAN SHACK: Just to come back to -- it sort of came out of Jocelyn's thing there. The uncertainty analysis in MELCOR are -- you're going to get this state of initial conditions that Rick is going to hand you. Are you then going to do uncertainty analysis on all the parameters involved in the severe accident uncertainties? Is that what comes -- I mean, you'll obviously first do a single point calculation. But how are you going to generate the uncertainties associated with that progression?

MR. SCHAPEROW: Yes, as you point out, we are going to do a single point estimate calculation for the sequence. We will do sensitivities along the way, to look at what we

think are the more important parameters and more important uncertainties and variables, and out of that we hope to be able to identify what are the most important uncertain parameters, and then later, let's say in the fall, after we have the initial calculations done, we hope to develop distributions for the more important parameters, and sample from those distributions, and develop a set of MELCOR input files for that one scenario, not just one input file but a set of them, and run MELCOR repeatedly in more of a Monte Carlo fashion.

DR. CORRADINI: So you are eventually intending -- I guess I just assumed it when Jocelyn put her thing up for source term -- you are intending to do Monte Carlo sampling, a series of -- you're going to develop a series of initial conditions for a MELCOR calculation that would be gotten by some sort of thing like a Latin Hypercube sampling approach?

MR. SCHAPEROW: Yes, that is our intention. As you may guess, it's very -- the actual calculations with such an approach is going to be very intensive.

DR. CORRADINI: I bet.

MR. SCHAPEROW: We're going to look for

ways to really pick the most important variables.

DR. CORRADINI: That's limited.

So my second question there is you said a step in there that I don't understand how you're going to do, which is you're going to do a point calculation, you're going to find out the things that are most important, take a stab at that, and then you're going to, with the sensitivities doing that, you're going to develop a distribution function.

That's the one, you know, kind a like when you go on the board and say, "It can be shown."

MR. SCHAPEROW: That's a hard step.

DR. CORRADINI: I'm curious how you're going to get that shape.

MR. SCHAPEROW: Well, we're going to have to use all of our experience that we have in this analysis.

DR. CORRADINI: What did they do in 1150 at this point, though, in difference? Did they not just --

MR. SCHAPEROW: 1150, when they came to hard questions they went out to an expert committee and they asked the experts --

[Simultaneous conversation]

DR. CORRADINI: But I remember being in rooms such as this and I remember --

MR. SCHAPEROW: -- what their distributions would look like.

DR. CORRADINI: Well, that's what I guess I'm kind of curious about. I remember end points but I don't remember a shape. I remember, there was a lot of discussion about it can't be lower than this and it can't be higher than that, and there was a lot of argument with those --

DR. APOSTOLAKIS: No. They had histograms.

DR. CORRADINI: Did they really?

MR. SCHAPEROW: Yes. They had, they listed for each issue, they listed each expert's distribution, and they combined them. Said expert A said this, expert B said this, expert C said this, and here's an amount, here's a composite of the three.

DR. CORRADINI: Okay. I forgot. Thank you.

MR. SCHAPEROW: It was --

DR. APOSTOLAKIS: Yes. They added the cumulative distribution.

MR. SCHAPEROW: That's the hardest,

that's perhaps the hardest step in this.

DR. APOSTOLAKIS: Hardest step is the cutoff frequency.

[Laughter]

MR. PRATO: Any other questions for this morning's presentation? Okay.

MR. TINKLER: I want to say, just on the uncertainty, we went through this same sort of process when we risk-informed 5044, to look at the amounts of hydrogen that might be generated during a severe accident, and we developed distributions of core melt progression models, salient model parameters based on PHEBUS data, based on the collection of severe accident data, and the committee may have seen it in some presentations, but when we then did the Latin Hypercube sampling using MELCOR to look at the amounts of hydrogen that might be generated during a severe accident, we actually compared it back to the distribution that were developed in new Reg 1150, and we showed that actually doing it more rigorously, our uncertainty was significantly smaller than what once was thought 15, 20 years ago, based on all the data we had and the models we had, when you do them in an integral fashion, we showed that the actual uncertainty in

core melt progression, at least that particular aspect of it, was not as large as is customarily assumed, and when people talk about severe accident behavior.

DR. CORRADINI: This is the output distribution of the results, is what you're saying?

MR. TINKLER: That's the output distribution.

DR. CORRADINI: Okay; got it.

MR. PRATO: Okay. I would appreciate if NEI and Peach Bottom, and anybody from Surry, if they'd just give me a minute of their time, so I can explain this afternoon's meeting. Other than that - -

DR. APOSTOLAKIS: Mr. Chairman.

MR. PRATO: Chairman. Sir?

DR. APOSTOLAKIS: They're done.

MR. PRATO: We're done with the presentation for this morning.

CHAIRMAN SHACK: Yes. We're actually even on schedule, amazingly enough.

DR. APOSTOLAKIS: Let's wait for four minutes.

CHAIRMAN SHACK: WE will adjourn for lunch now. I would point out that this afternoon's

session, up until our discussion at 4:00 p.m., is going to be closed. So we'll adjourn --

DR. APOSTOLAKIS: So discussion is open?

CHAIRMAN SHACK: Discussion is open. So be careful what you say in the discussion. We'll know the threshold frequency will come up. We'll adjourn until 1:30 then. We'll recess until 1:30.

[Whereupon, at 12:15 p.m., the meeting adjourned, to reconvene at 1:30 p.m., the same day, in closed session.]

DR. MAYNARD: Do we need to see if anyone's outside, to come in?

CHAIRMAN SHACK: I guess we can do that. I don't think anybody waited around, but it's possible. I guess one of the things that sort of, you know, this almost looks like an IPE.

DR. MAYNARD: I think the Reporter would like to ask you a questions.

COURT REPORTER: We're in Open Session, again, is that correct?

CHAIRMAN SHACK: Yes. The generalization of this, I mean as you're going through this thing you're looking at each vulnerability and then somebody takes a measure to eliminate it, that's a very nice thing.

But when I do my eight plants, you know, what about the other 92 or whatever it is, that you haven't analyzed. You know, what am I to conclude from this, anything?

Or is this really going to be so plant-specific?

DR. MAYNARD: I think you've probably learned quite a bit, just from what can occur in a plant. I think in the emergency planning arena, and the consequences off-site and stuff might be hard to

draw from the gate.

But depending on which eight plants are selected, if they truly select a pretty representative sample, most of them are having to do a lot of the same mitigation type actions and adding capabilities and stuff. So, that would be my guess.

MR. PRATO: In general, what came out of a lot of the security assessments, the new mitigating measures are basically the same, between these and BWRs.

MR. TINKLER: And I think when we started, when we started the project we did look at dominant, what we call dominant sequences for a broader spectrum of plants, frankly.

And, you know, there are the couple sites maybe that had some particular, greater common mode issues associated with them. But, a lot of them you would expect to see the same kinds of sites that I think we're seeing from just these two.

And there is a universality on the new measures, anyway. So, and I think also, I think it's also true that it's not surprising that, to a degree, we're going to be dominated by external events.

Because there's been, frankly, more

attention put on the internal events, and driving those frequencies down by the use of additional capability.

CHAIRMAN SHACK: Well, since you lead to SBOs, that's also a very challenging sort of thing.

MR. TINKLER: Sure, but I mean, you know, like the boilers, have been SBO dominated for ever, and the fact that they're still, and even more so, is not too surprising.

And then the PWRs are moving in that same direction. So, and the other point is in the past, this was a generic thing, I think.

In the past, there's been, I think, a little more focus on ISLOCAs and Event Vs, in older PRA. But the examination of them in this project, leads us to conclude that while they still may show up from time to time, they are more, as a general rule, more slowly developing.

They almost are always accompanied by this, somebody forgot to find new sources of water, okay. Because they're not, they're not also accompanied by the independent failure of lots of other systems.

Otherwise, the frequency of these events would be very, very low. So, the ISLOCA is why we

still show up, in some cases, or an Event V. They're not as challenging as they were in the past, in terms of timing.

So, I think that's also a sort of general finding. Because, while we still saw the ISLOCAs, they just, an ISLOCA at 20 hours and an ISLOCA at three hours, just from a risk perspective, are radically different kinds of events.

DR. ARMIJO: We're waiting for you, Mike.

(Laughter.)

DR. APOSTOLAKIS: What's your answer?

DR. CORRADINI: Five.

DR. APOSTOLAKIS: That's what I thought.

CHAIRMAN SHACK: To come back to another earlier question, you know, suppose we accept the ten to the minus six cut off, although George is not willing, perhaps, yet to do that.

But if you did, you still have to assure yourself that the uncertainties aren't pushing up any sequences. I mean, you know, we're dealing here with your kind of nominal frequencies for these sequences.

You, presumably, will have to go back and do an uncertainty analysis on those frequencies, to see if anything pops up. You know, will that

drive you, you know, to George's sort of thing where you're going to have to go down almost two orders of magnitude to escape the uncertainty that you have in the frequencies?

MR. SHIU: I believe the frequencies we use are the mean frequencies and they come with a distribution.

CHAIRMAN SHACK: Yes.

MR. SHIU: And I'm not sure the distributions would span two hours of magnitude. I mean I think they would span maybe a factor three, but, and we do look at sequences that are slightly below the cut off, to see if we should be considering those.

CHAIRMAN SHACK: Even in a sequence that was perhaps dominated by human error, you think you were still a factor of three?

MR. SHIU: For sequences that are dominated by human error is, we're probably off by, I mean the uncertainty would probably be more to the effect of a factor 10 or a magnitude.

CHAIRMAN SHACK: Still only an order of magnitude?

MR. SHIU: That's what we believe it to be.

DR. KRESS: Even if the distribution overlapped over fine line, you still have to decide how much overlap you're going to use, before you include it. They've already said that. No overlap.

DR. BONACA: In a way, I mean you are cut off at ten to the minus six. That almost proposes a definition for credible event or no credible event. I mean, one could look at it that way.

What does it do to your, the work that's just been done on the PAR Study?

MR. SCHAPEROW: On the what, sir?

DR. BONACA: PAR. In there you have, you know, fast release in 40 minutes of declaration of general emergency and the release.

MR. SCHAPEROW: I think they picked scenarios that were greater than how the core damage frequency rated ten to the minus six.

They had --

DR. BONACA: It was ten to the minus eight, in the scenario.

MR. SCHAPEROW: Ten to the minus eight?

DR. BONACA: Yeah.

MR. NOURBAKSH: He means frequency. It's the V sequence for Surry. The dominant plant damage in Surry.

MR. SCHAPEROW: I remember that was V minus five, but maybe that's not Surry. I left it about a year ago.

DR. BONACA: Ten minus six is initiating frequency. There's a vet frequency of that, because you get some credit for DF of the water too.

The question is whether or not you have the fast release of the measures, that you should consider in emergency planning. On the other hand you have the issue of security.

They propose these kind of scenarios. But I guess we'll talk about it on Thursday.

MR. TINKLER: I think, I think Randy Sullivan is thinking about those issues, and, because of some of the findings from this study. And, you know, even though it's a defense-in-depth, there's a limit to how much defense-in-depth you provide, given what your sense of probability is.

DR. BONACA: Except for --

MR. TINKLER: Except for, perhaps, security. Maybe that ultimately is the bottom line below which you --

DR. BONACA: You have to provide --

MR. TINKLER: -- have to provide.

DR. BONACA: -- a spectrum of response.

CHAIRMAN SHACK: Well, I mean even as a defense-in-depth measure, you probably still cast it towards the things that you thought were the most likely.

MR. TINKLER: Right, right.

DR. BONACA: Yeah, but you know, especially if you have events that you don't want to or cannot quantify as frequency, which could lead to rapid release, then you have to find for it.

CHAIRMAN SHACK: It becomes a question of emphasis. You know, do you try to protect yourself against the events you think have some chance of happening, or the ones that, you know, have much less chance but are worse.

But that's a different discussion.

MR. TINKLER: It's also the question of how, what's your ability to distinguish the event, when it happens. If you think you have an event that, are you going to have enough information to make that decision immediately to implement procedure or are you just simply reacting to the symptoms.

You know, it's a symptom-based EP. You've got, you detect very high radiation levels, in and around the site, and then you could implement

on that.

It doesn't necessarily have to be presupposed on a, on a sense of the frequency of the sequence.

DR. BONACA: I understand, you just implement. When you are planning to revise guidance for the Licensees to include stronger commitments to sheltering, for example, rather than evacuation, for very rapid scenarios.

You understand whether or not you really are going to have these rapid scenarios.

MR. TINKLER: Right.

MR. JONESA: I don't think either project is trying to make a decision on whether rapidly developing scenarios are credible. The point with PAR is that rapidly developing scenarios are currently included in the EPA planning basis, so we had to come up with a source term that was rapidly progressive, and that's what we did.

DR. BONACA: I don't criticize the study, I'm only saying should it lead to change in the recommendation on PAR, that's a different thing.

Given that there is this work going on, and, you know.

CHAIRMAN SHACK: Well, if there are no

further questions or comments, I think we can adjourn.

DR. CORRADINI: So did we get a commitment by Charlie and the group about the mitigation in and out relative to this, or is that something to be discussed later?

MR. SCHAPEROW: We are going to do the calculation both ways, with, assuming the mitigation works perfectly and has something that doesn't work at all.

Here are the consequences if it works perfectly, here's the consequences if it doesn't work.

MR. NEROKA: I think that and a couple of other things that came up, you know, in these two session, you know, we take some notes on some insights from the membership that we'll definitely will strongly consider.

And when we come back to you, I mean we'll give you some feedback on how we address those. Bottom line, there are no commitments.

(Laughter.)

DR. APOSTOLAKIS: No commitment, you should no that.

DR. CORRADINI: I know you're not a

Licensee, so we can't commitments out of you.

DR. APOSTOLAKIS: They are commitment-phobes.

DR. CORRADINI: That's fine, that's fine, thank you very much.

MR. PRATO: John, did you have any closing comments?

MR. MONNINGER: No, I guess, I just wanted to say thank you very much to the ACRS. I know it's been a while since we have, you know, haven't gotten back to you, but, you know, in the future, you know, we've really geared up for this project and we look forward to many more interactions with you.

You know, and as we indicated, you know, we owe some preliminary results to the Commission, in the September/October time frame, and we believe we need to come and, you know, discuss those with you, prior to that, too.

DR. APOSTOLAKIS: I really think we ought to have had an opportunity to write an interim letter as the work progresses.

Because now in the Fall, we're going to see the results.

CHAIRMAN SHACK: Results on the two?

DR. APOSTOLAKIS: Huh?

CHAIRMAN SHACK: The results on the first two. There's more.

DR. APOSTOLAKIS: Yeah, yeah. But I think it's kind of late, isn't it?

CHAIRMAN SHACK: Well, that's something we can discuss. I mean, we can write a letter at this point.

DR. APOSTOLAKIS: No, because there is no briefing of the full committee.

CHAIRMAN SHACK: Designated federal official.

MR. NOURBAKSH: We can ask them to come September, we write it for September, if you want.

DR. APOSTOLAKIS: Yeah, but that would be close to the final results, for these two. But, anyway, I mean the record is there, so you guys can have all the comments.

MR. PRATO: A lot has happened over a very short period of time. And we're moving extremely quickly with these first two plants.

DR. APOSTOLAKIS: Yeah, last time we met I think the approach was a little different, wasn't it?

DR. CORRADINI: When was it?

DR. APOSTOLAKIS: When was it?

MR. PRATO: It was December and we were planning to all 103 plants at that time.

DR. APOSTOLAKIS: In spite of what Don Dube said, it seems to me this is a missed opportunity to reevaluate the risk.

(Laughter.)

MR. PRATO: That's on the record, right?

DR. APOSTOLAKIS: And it's not an order of mine, Don.

MR. DUBE: Fifteen to 25 person-years for a level 3 PRA.

DR. APOSTOLAKIS: Yeah, but I mean when do you start? Do you start from scratch? Do you start from the existing 1,150 studies?

DR. CORRADINI: He's got a second wind, now. Now you've got him going.

DR. APOSTOLAKIS: No, I don't think it's an order of mine.

MR. NEROKA: If I may, just one thing you mentioned about the question of writing a letter or no letter, you were talking about that.

I just want to point out, working with the ACRS on this project is, you know, that's part of the Commission direction. That's examples of

technical matters, like sequence selections and what nots, you know, all these things that will need to come to ACRS on.

So, at any point, if you feel there's any specific topics, you want to consider, you know, to write something on. If you want us to come back and tell you more.

DR. APOSTOLAKIS: Well, it's too late for tomorrow.

MR. NEROKA: You know, just so you know.

DR. APOSTOLAKIS: So the results, I mean we're talking about December now?

MR. SCHAPEROW: September.

DR. APOSTOLAKIS: Oh, you will come back in September with results?

MR. SCHAPEROW: The first two.

DR. APOSTOLAKIS: Wow, wow. That's lightening speed.

CHAIRMAN SHACK: Fast track.

MR. NEROKA: September, maybe October, I mean, in the Fall.

(Laughter.)

CHAIRMAN SHACK: Summer vacation disappeared. August disappeared on you.

CHAIRMAN SHACK: All right. Okay, we'll

adjourn.

(Whereupon, the above-entitled matter was concluded at 5:17 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards Regulatory Policies and Practices

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

State-of-the-Art Reactor Consequence Analyses (SOARCA)

ACRS Regulatory Policy and Practices
Sub-Committee Meeting
July 10, 2007

SOARCA
ACRS Subcommittee Meeting

Agenda

- Project Overview
- Accident Sequence Selection
- Containment System States
- MELCOR
- Emergency Preparedness
- MACCS2

SOARCA

Project Overview

Robert Prato

SOARCA Goal and Objectives

Goal

Develop a state-of-the-art, more realistic evaluation of severe accident progression, radiological releases and offsite consequences for dominant accident sequences and replace such as NUREG/CR-2239, "Technical Guidance for Siting Criteria Development."

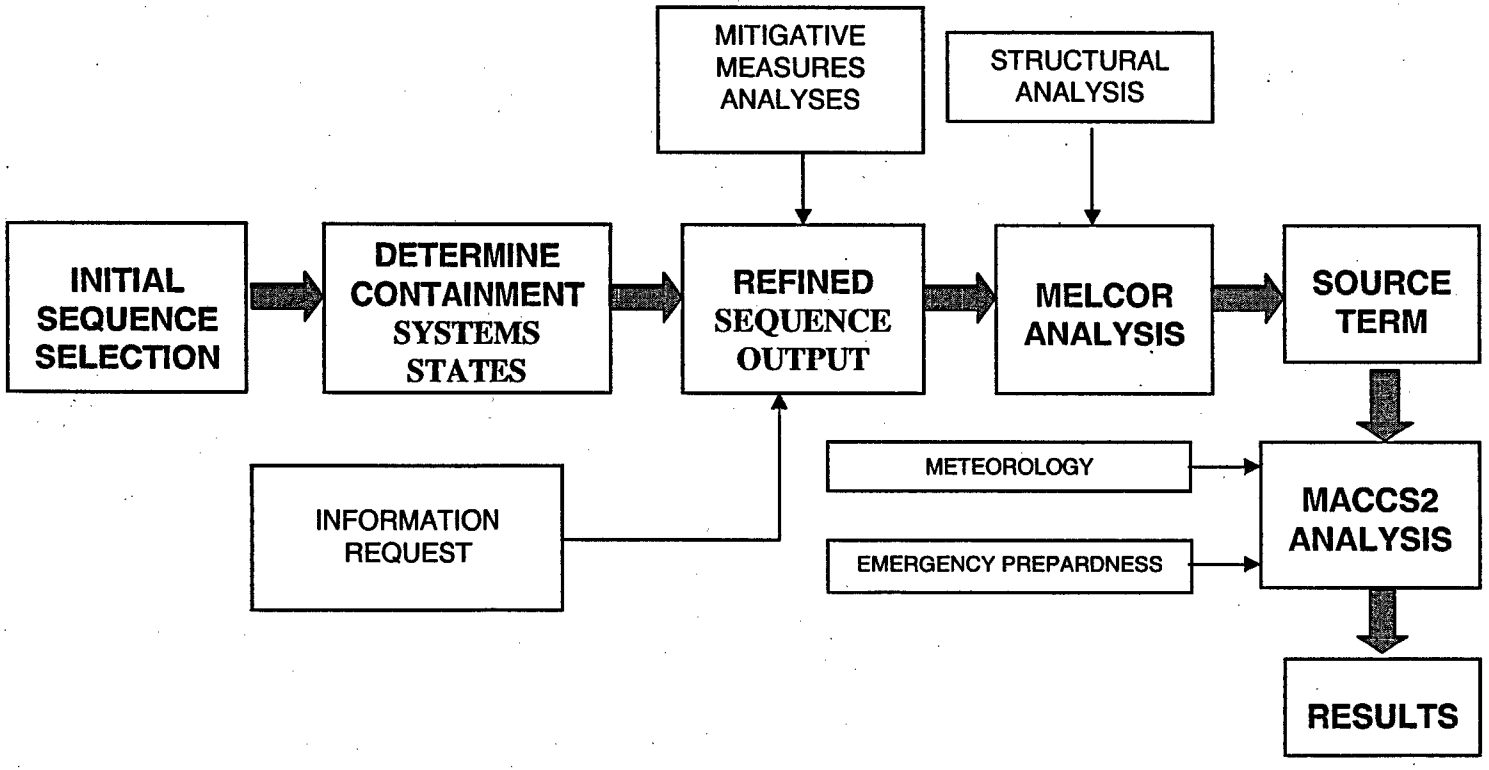
Objectives:

- Determine best estimates of the radiological consequence
- Evaluate and update analytical methods and models
- Include mitigative measures and plant improvements
- Use updated emergency planning modeling assumptions.
- Incorporate effective risk communication techniques

SOARCA Status

- Communications
  - Press Release – Issued May 7, 2007
  - OPA prepared Fact Sheet
  - Web page
  - Frequently asked questions
  - Links to related sites
- Project Plan
  - Initial scope of not more than eight plants
  - Start with a BWR (Peach Bottom) and a PWR (Surry)
  - Results will be compiled and released to the public after the project is complete

SOARCA PROCESS



Sequence Selection

Internal Events

Perform initial screening to screen out low CDF initiating and group remaining sequences based on time to core damage and equipment unavailability to identify dominant sequence groupings with a CDF $\geq$ 1.0 E-6 ($\geq$ 1.0E-7 for bypass events).

External Events

Identify the dominant externally initiated event sequence based on NUREG-1150, IPEEE submittals, external event SPAR (SPAR-EE) model, and/or generic insights to select representative sequences and to qualitatively assess related risk.

Containment System States

Identify the anticipated availability of containment and containment support systems that can impact post core-damage accident progression, containment failure, and radionuclide release.

Mitigative Measures

For each sequence groupings within the scope of the site-specific analyses, identify applicable mitigative measures that can potentially prevent or delay core damage, RCS failure, and/or containment failure and the approximate time for implementation after the initiating event for input into the MELCOR analysis.

Structural Analyses

Perform structural evaluation of containments to determine functional failure pressure (leakage) and structural failure pressure (rupture), and to develop leakage rate and/or area as a function of internal pressure.

MELCOR

- MELCOR Code Improvements model improvements are complete.
- Develop a plant-specific model for each plant being analyzed.
- Perform accident progression analyses for each plant using MELCOR computer code to determine source term, potential containment failure state and time, and time of release as input in the MACCS2 analyses.

Emergency Preparedness

Model the protective response afforded by current site-specific Emergency Preparedness (EP) Programs.

MACCS 2

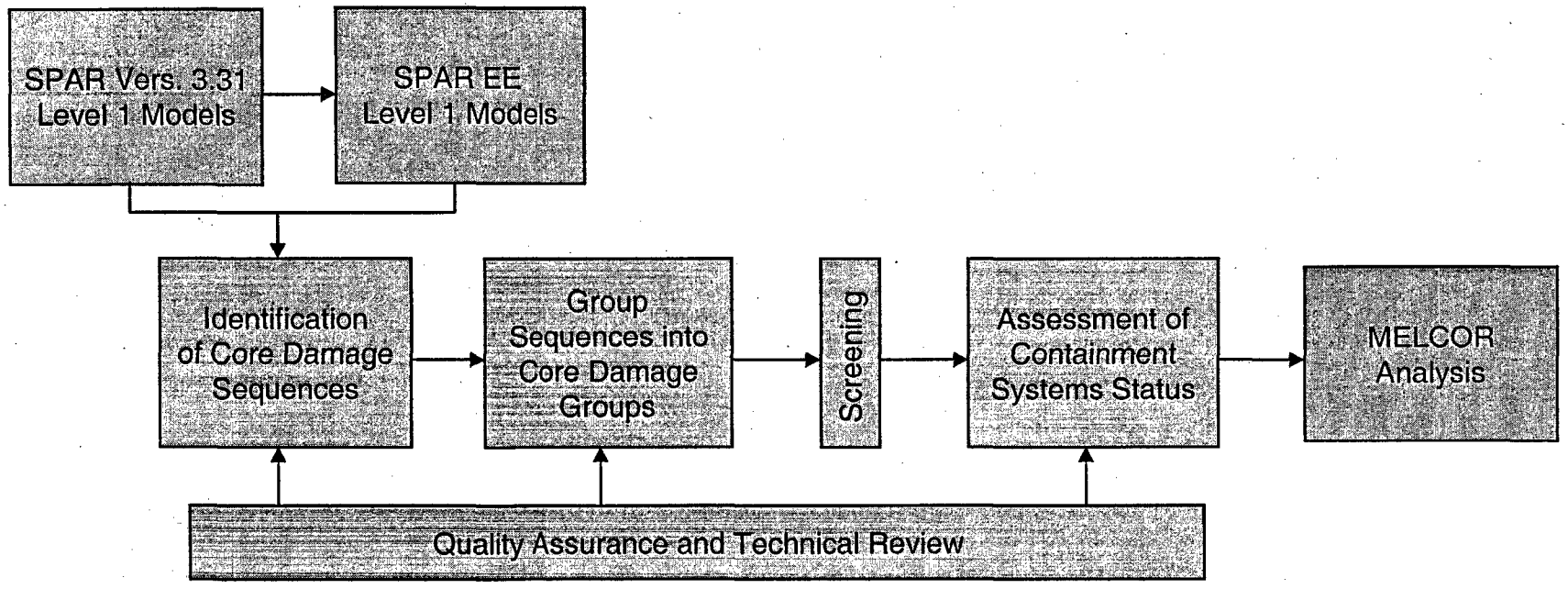
- MACCS2 Code model improvements have been completed.
- Develop a site-specific model for each plant being analyzed based on meteorological data and emergency response parameters.
- Perform consequence analyses for each plant using MACCS2 computer code to determine early fatalities, and latent cancer fatalities.

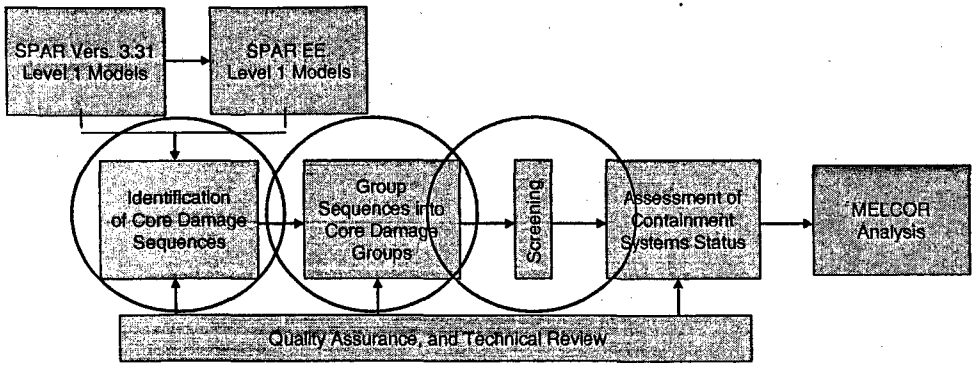
SOARCA

Accident Sequence Selection
and
Containment System States

Richard Sherry

SOARCA Accident Sequence Identification and Characterization



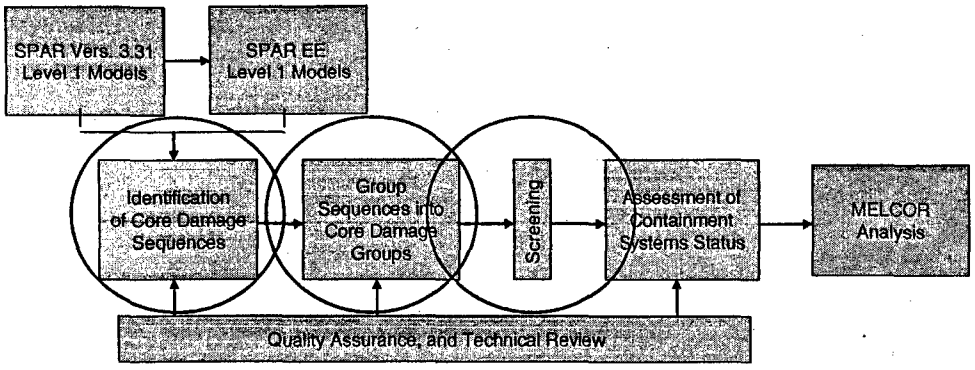


Internal Events

- CD sequences determined using plant specific "Level 1" SPAR models and licensee PRA results
- Selection process considers groups of sequences
- Identify sequence groups with freq. $>10^{-6}$ per RY for most sequence groups and $>10^{-7}$ per RY for sequence groups that are known to have the potential for higher consequences

Outputs

- Internal event (IE) CD sequence groups, the individual sequences included in the group and the group frequency
- Description of the dominant IE sequences included in each sequence group
- Dominant IE sequence cutsets and their descriptions

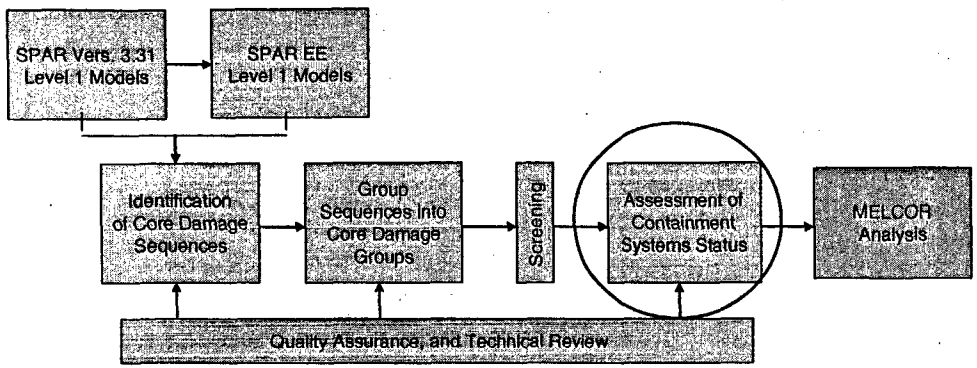


External Events

- Determined using available plant/design-specific assessments (e.g. NUREG-1150, IPEEE, etc.)
- SPAR-EE information used when available
- Generic insights also used to define and select representative sequences

Outputs

- Representative sequences for EE initiators with estimated frequency ranges
- Sequence descriptions, containment systems status, and a sequence frequency estimates are provided
- Report documenting sequences and basis for selection

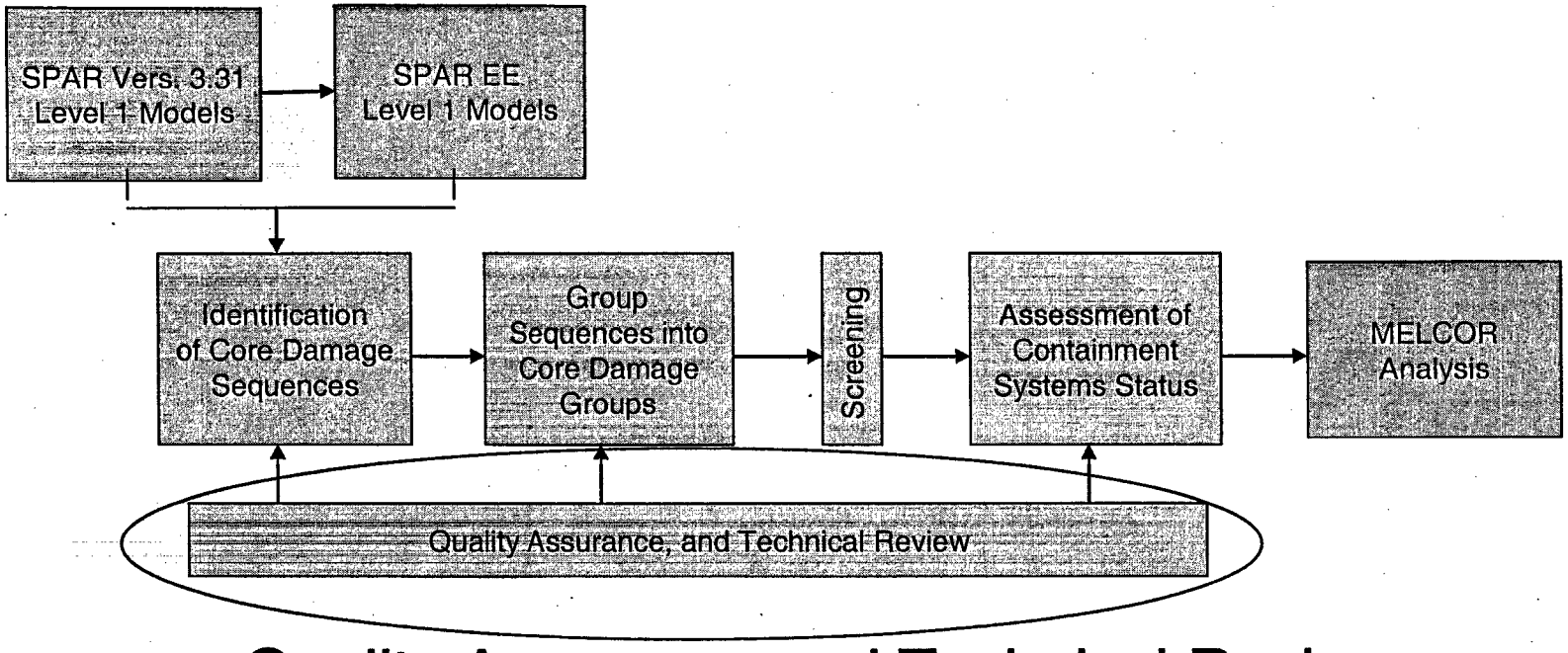


Containment Systems Status

- Availability of systems that impact post-core damage
  - containment accident progression
  - containment failure
  - radionuclide release
- Use system dependency tables and existing SPAR system models

Outputs

- Availability of containment systems for identified sequence groups.
- Availability of "Level 1" systems that impact containment accident progression
- Identification of important plant physical states (e.g. RPV pressure at core damage) and sequence timing



Quality Assurance and Technical Review

- Cutset level reviews from Level 1 SPAR core damage models with licensee PRA results.
- Peer review by an internal review panel

SOARCA

MELCOR

Jason Schaperow

MELCOR Improvements

- Fission product release and deposition
  - CORSOR-Booth release model benchmarked to PHEBUS and VERCORS tests
  - Cesium volatility based on vapor pressure of cesium molybdate)
  - Aerosol release from Ag-In-Cd control rods and from zircaloy (Sn)
- Explicit accounting of mechanisms for relief valve seizure (fail open) and resulting depressurization
- In-vessel debris behavior
  - Modeling of molten pool formation with possible crust formation
    - Modeling guided by ongoing TMI assessment
  - Modeling of the core shroud failure and the bypass region between shroud and core barrel
  - More detailed representation of material relocated to lower plenum and of the bottom head

MELCOR Improvements
(BWR)

- Updated fuel assembly and core data
  - Geometry and material composition for current 10x10 fuel design
  - New estimates of decay power and fission product inventory for mid-cycle and end-of-cycle
  - Spatial distribution based on axial and radial power data for several recent cycles
- Refined description of reactor upper internals
  - Radionuclide deposition surfaces
  - Heat sinks influence advection to steam line nozzles and potential for steam line creep rupture

MELCOR Improvements
(PWR)

- RCS at high pressure with core uncovered – improvements from ongoing effort with SCDAP/RELAP5 and CFD on thermally induced tube rupture
- Natural circulation modeling
  - Steam-to-wall radiation
  - Heat loss from RCS to containment provides 2 MW heat removal (at 10 hrs., decay power is 20 MW)
  - Hot leg natural circulation rate matched to observations from recent CFD calcs
  - Hot-leg-to-tube recirculation ratio (2.0) and inlet plenum mixing fraction (85%)
  - Individual pressurizer relief valves to better reflect natural circ. flow disruption
- Pump seal leakage modeling
  - Seal leakage location updated
  - Simplified leakage model flowrate (vs. pressure) compares well with detailed models
- Creep rupture modeling
  - Both carbon steel hot leg nozzle and stainless steel hot leg piping included
  - More accurate stress formulation (previously used a thin wall formulation)

SOARCA

Emergency Preparedness

Joseph Jones

EP Modeling

- Modeling the emergency response afforded by NPP Emergency Preparedness programs substantially improves realism
- All NPPs have regularly inspected and exercised EP programs
- Modeling realistically represents NRC Defense-in-Depth Policy

EP Modeling Assumptions

- Officials will implement emergency plans
- The public is expected to obey direction from officials
- Emergency workers will implement the plans
- Basis from NUREG/CR-6864, "Identification and Analysis of Factors Affecting Emergency Evacuations" and PAR Study Focus Groups

WinMACCS Revisions For EP Modeling

- Allows up to 20 cohorts
- Each cohort may change speed 3 times
- Allows road network to be modeled
- Allows evacuation speed to be changed in any grid element to model freeways and bottlenecks

SOARCA

MACCS2

Jocelyn Mitchell

MACCS2 Improvements

- User-friendly interface, called WinMACCS
- Memory management
- More cohorts for evacuation
- Enable network evacuation
- Evacuation speed change by grid element and for precipitation
- Alternative models for latent cancer dose-response

MACCS2 Improvements (cont.)

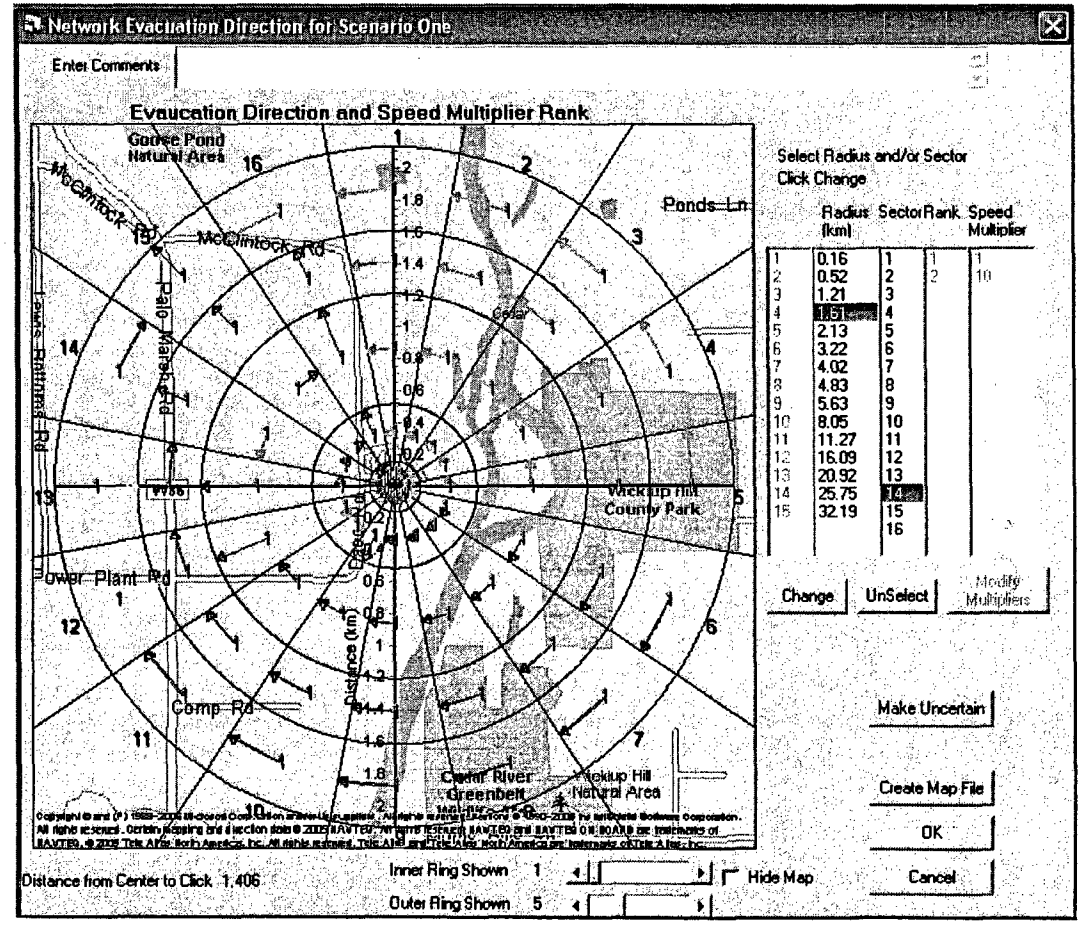
- Plume rise model (older Briggs model)
- Plume meander Reg Guide 1.145
- Potassium Iodine (KI) ingestion
- Long range lateral plume spread
- More compass directions
- More plume segments to model release
- Shorter than 1-hour time intervals in meteorological file

MACCS2 Improvements (cont.)

- Parameter uncertainty can be assessed
  - Meteorological as usual (sample from weather bins)
  - Source term - repeat use of equally-likely samples from MELCOR
  - Ranges of values, degrees of belief for floating point variables
  - Latin Hypercube sampling

Enable Network Evacuation Model

Network Evacuation Model – Evacuation Direction and Speed Interface



Dose Conversion Factor File

- Based on Federal Guidance Report 13
  - Equivalent to ICRP Publications 68 and 72
- MACCS2 data file set consists of 51 files
  - 50 DCF files for one year's worth of dose commitment – years 1 through 50
  - 51st file DCF for a fifty-year dose commitment
- Cloudshine, groundshine based on FGR 12

Input Values Other Than Site-Specific

- US/CEC study "Probabilistic Accident Consequence Uncertainty Analysis"
  - Elicitation of "experts in the different scientific disciplines featured within an accident consequence code"
    - Atmospheric science, radioecology, metabolism, dosimetry, radiobiology, economics
  - Use 50th percentile of distribution