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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

April 8, 2005

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

521st MEETING

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FRIDAY, APRIL 8, 2005

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ROCKVILLE, MARYLAND

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The Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. Graham B. Wallis, Chairman, presiding.

MEMBERS PRESENT:

GRAHAM B. WALLIS	Chairman
WILLIAM J. SHACK	Vice Chairman
GEORGE E. APOSTOLAKIS	Member
MARIO V. BONACA	Member
RICHARD S. DENNING	Member
THOMAS S. KRESS	Member
DANA A. POWERS	Member
VICTOR H. RANSOM	Member
STEPHEN L. ROSEN	Member
JOHN D. SIEBER	Member-At-Large

ACRS STAFF PRESENT:

JOHN T. LARKINS	Director
MICHAEL L. SCOTT	Chief, Technical Support Branch
SAM DURAISWAMI	ACRS Staff, Designated Federal Official
HOSSEIN NOURBAKHSH	ACRS Staff

AGENDA ITEMS PAGE

P R O C E E D I N G S

(8:25 a.m.)

CHAIRMAN WALLIS: Okay. The meeting will now come to order. Good morning. This is the second day of the 521st meeting of the Advisory Committee on Reactor Safeguards.

During today's meeting, the Committee will consider the following: Accident Sequence Precursor Program and development of SPAR models, future ACRS activities, the report of the Planning and Procedures Subcommittee, reconciliation of ACRS Comments and recommendations, and preparation of an ACRS report.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act.

Mr. Sam Duraiswamy is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments nor requests for time to make oral statements from members of the public regarding today's sessions.

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

The first item of business is the ASP Program and development of SPAR models. I turn to my right-hand man Dr. --

MEMBER SIEBER: Mister.

CHAIRMAN WALLIS: -- Mr. -- whatever, Jack Sieber to lead us through this. Thank you, Jack.

MEMBER SIEBER: Thank you.

To me, I consider the work that is being done by the staff here as important work. It's sort of the check and balance on both licensee activities and our modeling of events and their likelihood and the possible outcomes. And so this, to me, is sort of a quality control check on that.

And today the staff will tell us about a couple of incidents that have occurred which have been analyzed by the staff to determine their significance.

And one of the things that I had asked early on for the staff to possibly address, to the extent that they can, is what insights does the ASP Program give the staff and us with regard to the ability of the SPAR models to be able to predict or forecast or tell us something about the safety of the fleet of nuclear plants as they exist today.

To me, that's an important aspect of this.

Since the Agency has adopted a risk informed approach to regulation, this becomes one of the cornerstones for that risk approach.

And so with that, I would like to introduce the staff. The Branch Chief responsible for this is Mr. Chokshi and with that, I will turn it over to the staff to give us introductory remarks and the presentation.

MR. CHOKSHI: Well, good morning. And as Dr. Sieber mentioned, my name is Nilesh Chokshi. And this is my first appearance in front of this Committee in this new position. And after having been in the Division of Engineering for 15 years, this has been quite a change. But the change has been an exhilarating and very rewarding learning process.

And I think more importantly to me on a personal note, I'm enjoying every bit of working with my new colleagues as I did with working with my colleagues in the old position or previous position. So that has been good.

With that, now I think I want to thank Committee for giving us opportunity to come and talk about three or four programs.

In the Branch, the OERA, the Operating Experience Risk Analysis Branch, has several major functions. And I think with the development of plant-specific risk assessment models, SPAR models, has been used by Agency for many risk-informed regulatory activities. That has been one of our major activities.

We develop and maintain operating experience database systems. We are providing input to the Agency's industry train programs and we are using accident sequence precursor analysis to evaluate the risk associated with the conditions and events. And you're going to hear a lot more about this today.

We have been monitoring the Reactor Oversight Program, development of the performance indicators, particularly the MSPI, the Mitigating Systems Performance Index. And you are also going to hear a little bit about the relatively new program, the standardization of the Agency risk assessment process, RASP.

About a year and a half back, I think in October 2003, the Branch had a day-long briefing with the Reliability and Probabilistic Risk Assessment Subcommittee on all of the programs. Today we're going to concentrate on the SPAR model development and ASP. And hopefully I think we'll get to some of the insights, particular insights, that you requested.

The briefing is divided into the four main technical elements. Gary DeMoss, who is operating the slides, he's going to brief on the ASP-related projects. And Pat, to my right, will discuss the progress of the SPAR model development project. And Mike, in the end, I think is going to focus on the part forward, where we are going and what are the challenges.

While Gary and Pat are going to do the briefings, the technical briefings, what I really want to point out that both ASP and SPAR are team activities. And many of the Branch members are involved if not all. Some are involved in directly supporting, doing the -- conducting the ASP analyses, reviewing the ASP analyses, developing SPAR models while others are supporting the data development, procedures development.

I want to also mention some of the key players. And Don Marksberry has been the PM for the ASP Projects for the last five years. And he has really led a well-organized and excellent program. And along with Don, Gary has been providing the technical oversight. And Gary also has the special privilege of presenting today because he has done the Davis-Besse analysis and a few other things.

Pat, I think -- I don't know whether he needs introduction but he's been SPAR guru for over many years. But he is also being assisted by Salim Sanjector and I don't see him here. But he's developing actual event models. And Eli is developing the hot models.

And as Don is going to -- we are going to focus on modeling the ASP plans and insights. So Eli is taking over the project management responsibility.

I also want to, again, I think mention that, you know, many others are involved. And I'm particularly, I think, are too important, I think that there are -- about half of the ASP analyses are conducting in-house. Okay, and we are in process of getting some more new staff members.

So I think our focus is going to be on involving these people because it's a good, I think, training and developing skills on using risk assessment procedures. So this is -- I think this project has been very good in terms of training some of the people. In fact the two examples we're going to discuss today are both in-house analysis examples.

Let's go to the next -- now I view this as an information briefing. And you can, you know, correct me but we are going to update you on the current status of the ASP Program and also describe some of the trends. But the bulk of the material is going to come from the SECY paper we just had in November 2004 and supplement with some other information.

And I think as requested by the Committee, we will also discuss the Davis-Besse ASP analyses. The analyses is now out in the public. Now we have included the August 14th, 2003 nuclear event analysis that I think is another important informative example.

There are about two slides. But I think if time begins to be a problem, I propose that this may be one we may want to skip over because I think even with the two slides, the question/answer phase could be pretty extensive on that.

And Pat is going to describe the SPAR models and the insights and then Mike will follow.

Let me just briefly mention about this Risk Assessment Standardization Project. I think both Pat and Mike will be alluding to that later. As you know, the risk assessment of reactor events and conditions are performed by many groups in the NRC. And there has been an issue of different answers.

So I think there are a lot of benefits of standardizing some of the procedures, methods, and models. And this will, I think -- this includes having duplication of efforts, inconsistent outputs, conflicting results. And if nothing else, the detailed documentation will help save time for people to go and find out what to do, how to do, and also, again, it's an educational tool.

So we have been working with -- in fact with NRR, as a user need, and working with the region and the NRR in developing standardized procedures. At this point, I would consider that we are in the beginning phases of that. And at some point, maybe later, we can come and tell you as we progress forward.

We'll briefly talk about the background of the ASP Program, which I don't think there's need to go too much into the details. But I think I'll just mention a few things. The ASP Program was established in 1979 in response to the risk assessment review group report.

And the primary purpose, I think, as stated on the slide is to systematically evaluate operating experience to identify and document events likely to lead to core damage. I think in other words, in ASP analysis is a plant-specific analysis performed to determine the condition or likelihood of a core damage given an initiating event and in plant equipment failures or --

CHAIRMAN WALLIS: Likely is a funny word here because really it's not very likely that there will be core damage.

MR. CHOKSHI: Well, the conditional probability of --

CHAIRMAN WALLIS: A very low conditional probability.

MR. CHOKSHI: Right.

CHAIRMAN WALLIS: But the word likely sort of implies it is quite a high probability.

MR. CHOKSHI: Yes. And I think on the next slide where you see more formal, I think it's conditional probability.

MEMBER APOSTOLAKIS: Those events that might lead to core damage.

MR. CHOKSHI: Right. The ASP Program provides the basis for two performance indicators. The no event per year are identified as significant precursor of a nuclear reactor accident and also they put the statistically significant adverse industry trend.

In addition to those performance measures which are required to be put into the accountability and performance report, the other objectives are, you know, to categorize the precursors by their plant-specific and generic implications and factor insights into the regulatory process I think to provide the potential PRA scenarios and models. And I think that was in the ACRS letter of May 16th, 2003.

CHAIRMAN WALLIS: So how do you check a PRA scenario?

MR. CHOKSHI: Okay. I was just going to say that there was a letter from ACRS on May 16th, 2003. And they had particularly said that the ASP Program, they agreed that it is a very important element. And I will draw up under my --

CHAIRMAN WALLIS: So if the PRA scenarios deal with the probabilities and ASP deals with real events that happen and the connection, because they're rare events, must be very tenuous.

MR. CHOKSHI: Right.

MEMBER APOSTOLAKIS: No, ASP --

CHAIRMAN WALLIS: You can get the sequence but you can't get the probabilities, can you?

MEMBER APOSTOLAKIS: No, ASP also considers scenarios, right? It starts with what happened and then it becomes a PRA.

CHAIRMAN WALLIS: And then it becomes a

PRA. Then it goes into what might have happened.

MEMBER APOSTOLAKIS: Then it becomes logical in Russia.

(Laughter.)

MR. CHOKSHI: And the insights, in fact, come from, for example, I think about 20 percent of the events require developing some modeling and things, you know, which was not in the PRA models. So there is a feedback process.

CHAIRMAN WALLIS: So one is reality and the other is realistic.

MEMBER SIEBER: That 20 percent is an important number.

MEMBER APOSTOLAKIS: What is that?

MEMBER SIEBER: You know it basically says that PRAs don't model everything.

MR. CHOKSHI: Right. And so there is a feedback process.

MEMBER APOSTOLAKIS: Well, you know, a major problem with the ASP Program over the years has been the dissemination of information and having people who actually do PRAs pay attention. It's not your fault. But, I mean, this is really an important part of what the Agency does.

MEMBER SIEBER: That's right.

MEMBER APOSTOLAKIS: And you go out there and people don't seem to, you know, be aware or they say oh yes, well I've heard of it. But you never hear a PRA analyst say, oh, in this sequence, you go that way because ASP found such and such.

I don't know. I mean is there a solution to that? I mean I know that you guys are issuing reports.

MEMBER BONACA: Well, I would like to comment on that. I mean in the past, okay, one of the issues has been the quality of the models that the NRC has used to develop the scenarios. And the credibility of the results to the very licensees that were being evaluated.

So typically you had an evaluation. It was off by an order of magnitude of two, the results. You look back at the modeling, you find the certain fundamental elements of the plant were missing from the models. So you communicated back the information.

This was when it was being done -- I think it was outsourced at that time. And you can get back to have them consider the modeling aspects. Then the document would be issued with certain numbers that really were off the wall. So it became unimportant because it didn't provide credible results.

Now I think, you know, I see this as very positive. You know, the development of the SPAR models that are becoming more and more close to the model. And I think that would bring about credibility to the program and to the results.

MEMBER APOSTOLAKIS: But in answer to that, first of all, the situation you described, I think, is kind of old. Now, I mean --

MEMBER BONACA: I don't know.

MEMBER APOSTOLAKIS: -- the program has been -- has improved significantly over the years.

MEMBER BONACA: I would expect so, yes.

MEMBER APOSTOLAKIS: But second, it's not so much the number I'm talking about. I'm talking about the dependencies and the paths that these guys find which is independent of -- well, I mean you can say no, they missed the particular component or system or action. But by and large, I don't think that the various dependencies or scenarios that have been identified as part of the operating experience have really influenced the event trees that people develop.

Now that doesn't mean that these event trees are no good because maybe they have other sequences that subsume these sequences. But it would be nice to see a more active use of what this Branch is producing.

MR. CHOKSHI: Sure.

MEMBER APOSTOLAKIS: I think obviously you have looked at the ACRS letter. I think we mention that every now and then.

MEMBER ROSEN: Well, I think the early problem was the one that Mario described. They were not credible. But the staff has done a good job bringing these models to the plants and benchmarking them against the plants' PRAs.

And when the plant PRAs and the SPAR model, in whatever stage of development, were different, the differences were explored. And either the plant model was corrected or the SPAR model was corrected to bring them closer together.

Now that's not to say that the SPAR model is exactly the same as the plant model. It can't be. I don't think they can be that big. But that's the state of knowledge right now.

So the plants -- you can understand why the plants weren't too interested, as Mario described, in the early times. Now they're very interested. And they expect the answers for a given event to come out very much the same.

And if they don't, then there is an issue.

And that issue is on the table in front of both the staff and the industry and the plant and the public. And one can see the difference.

And the difference comes down to saying, for example, we talked yesterday about HRA, the Human Reliability Announcement. What numbers are you using for human actions? Well, you, of all people, know, George, you can pick -- a lot of different numbers can be picked.

So those differences now are worthy of discussion whereas before they weren't because the models were so wrong.

In the early days, I must confess that I didn't think this program was a good idea. And the reason I didn't was because the models were so not credible. They were so far behind the plants' models. To the extent that I even proposed at one time that the whole program be stopped and instead that the plant models be given to the NRC.

Then you could do whatever you want with them but at least you'd be starting at the same point. Well, that's no longer necessary, of course, because you've come across to the point where SPAR models are, I think, universally -- have you gone through every plant and benchmarked them?

MR. O'REILLY: Yes, we have.

MEMBER ROSEN: Okay. So now you're at the point where this becomes quite useful I think. And I think Jack's earlier point that the Agency needs an independent method is true. And this becomes that.

MEMBER SIEBER: Yes.

MEMBER ROSEN: But to the degree that it's independent is only because you each have a model that was generated by your own generating process rather than taking a model and cloning it and then using it. But I would say that's the reason the plants weren't interested in the early days.

They were just a problem to have to deal with the fact that, okay, you come in -- for a given event that the plant has said is a no, never mind, because we know that this plant, there are all kinds of systems and go look at the -- and then the staff says no, it's an extremely serious event.

And you go look at it and the model doesn't include two or three systems. Well, it's not the plant.

MEMBER SIEBER: I think one of the things that has enhanced the licensee attention is the use of risk analysis for significance determination. And now all of a sudden it's under the reactor oversight process. It's in the licensee's best interest to have pretty good models that will describe the probability of events. It's in their financial interest and in also their operational interest.

And so you may want to address a little bit about the connection between this kind of work perhaps when you talk about the Davis-Besse event and the significance determination process. And give us your insight.

MEMBER ROSEN: With this introduction, would you also address the fact that plant models are evolving. They're not static. They're being improved. And we heard yesterday that some models are less than perfect. And so there may be some rather large improvements someplace.

So how do you intend to deal with that? Are you going to go back to plants and re-benchmark on a regular basis? Or something --

MEMBER APOSTOLAKIS: I have a clarification question. Is ASP and SPAR the same thing? I know physically it isn't. But in terms of body of knowledge, what they represent. Because we keep using the words interchangeably it seems to be.

MR. CHEOK: Well, let me try to clarify that. SPAR is basically our PRA models.

MEMBER APOSTOLAKIS: It's a model, right.

MR. CHEOK: And ASP is basically the program to evaluate

MEMBER SIEBER: It's a process.

MR. CHEOK: -- operating events at the plants using the SPAR models.

MEMBER APOSTOLAKIS: But does the SPAR model, though, reflect all the findings of ASP? Or is it a model that is produced, you know, as the result of the efforts of the staff and then interactions with the utility?

MR. CHEOK: We will update the SPAR models on an event-specific basis to be able to model the events correctly. I guess I'd like to elaborate on what the Committee has talked about earlier. You know we have -- the ASP Program has, in the past, identified events like the fragile ice and the seaweed in the intakes. And these are events that are now being taken into account in plant PRAs.

We also have identified events like operator actions that are not in the procedures. Or alternate success paths that the plants have taken in response to plant events but because these paths and procedures they're not officially in procedures, a lot of plants will not take credit for these procedures in the PRAs because of the different standards.

So although we do identify about 20 percent that's not modeled in PRAs, a lot of times there's a good reason for why they are not in there because the plants feel that the sequences that they model are conservative enough that they do not have to include sequences that, you know, they could do based on operator knowledge that may not be "acceptable" under the AMSE PRA standards.

MEMBER APOSTOLAKIS: So, Mike, are you then answering in part or in total the finding that Carl Flemming had in his report that he was told by the staff, the NRC staff or some of the NRC staff that about 20 percent of the initiating events identified in ASP are not included in the PRA or something like that?

MR. CHEOK: Well, it could be they were not included at that point. But like I have the example I provided, once they are identified and eventually if they become prominent enough or important enough to a plant, I believe that they will be included in the plant PRA.

MEMBER APOSTOLAKIS: And do you have any idea how that happens? Is it because somebody is pushing? Or --

MEMBER ROSEN: No, it's the update requirement.

MEMBER SIEBER: Yes, the event occurs and you --

MEMBER ROSEN: You have a two-year update requirement to input operating experiences.

MEMBER APOSTOLAKIS: Well, update --

MEMBER ROSEN: The models and the data.

MEMBER APOSTOLAKIS: Yes, but I mean, you know, I can update it and -- I mean update is a very general term.

MEMBER ROSEN: Yes, but I know a good update includes the operating experience of the plant itself since the last update and any new models, any new sequences that have been determined to be significant.

MEMBER SIEBER: I think it's important to recognize that the 20 percent will never go to zero. And that's because of the issue of what do you take credit for which is your point.

MR. CHEOK: To answer George's question directly, the staff has no formal process to make a licensee include some of the events that we find. But I want to substantiate what Mr. Rosen said basically is that if you follow the PRA ASME standards procedures, it requires that you update your PRA with plant-specific events, especially those that are relevant to your plant.

So if they follow those procedures, they will pick up on the --

MEMBER ROSEN: Wait a minute -- if is not the right word. Some plants have gotten license changes that require updating in accordance with the ASME standard. It's a part of the license of a plant. So the if isn't -- it's when they follow their procedures that require updates.

MR. CHEOK: Sorry.

MEMBER ROSEN: All right. I just wanted to correct that. It's not so loosey-goosey as you say.

VICE CHAIRMAN SHACK: But we could let the staff proceed with their presentation rather than our freeform discussion if it's okay with --

MEMBER APOSTOLAKIS: We could.

(Laughter.)

MEMBER SIEBER: We could.

MEMBER ROSEN: We have not typically done so.

MEMBER SIEBER: You basically had a 25-minute introduction. So let us move on.

MR. CHOKSHI: We will come back and address the question you raised about the SPAR models also during the presentation. I think I was going to also mention the National Academy of -- you know, their study about the use of accident precursor sequence analysis and its value. It has been very positive. And I won't say any more than that.

MEMBER APOSTOLAKIS: But this workshop took place what -- three years ago?

MR. CHOKSHI: But the report came out --

MEMBER APOSTOLAKIS: Yes, I know.

PARTICIPANT: It took three years to write.

MEMBER APOSTOLAKIS: Speaking of updates.

(Laughter.)

MR. CHOKSHI: Well, let me move on to the next slide because I think that as part of the SDP and the ASP issue, the question, I know, often comes up, you know, why we are doing both and what are the differences.

ASP, you know, as I mentioned, it's to evaluate whether a particular event or condition is a significant precursor. And I think as noted in the applicability, it considers concurrent multiple degraded condition. And you'll see that in the Davis-

Besse discussion. And some differences between SDP and ASP.

While SDP is basically -- using risk insights to consider degraded condition or inspection findings to determine the significance in the model for regulatory response. So I think the timing is a big factor. The SDP should be done pretty much, you know, very quickly to make some decisions. And that timing effects how we can do the analysis.

I think that's basically this. The difference is here on the information, on the modeling, and uncertainly, it reflects the availability of time and information.

MEMBER APOSTOLAKIS: But the idea is the same, though.

MR. CHOKSHI: It is true. We are trying to get to the -- but I think the big difference is these multiple conditions.

MEMBER APOSTOLAKIS: Even SDP considers multiple, doesn't it? This Committee recommended that that's not the way it should be done and we got the reply yes, we agree. Wait a minute, wait a minute. We made a big deal out of it, you remember?

That if they find three -- if they have three findings, they shouldn't do each one separately if they are concurrent. And we got the response from the EDO that yes, we agree with you.

MR. CHEOK: I think the purpose of the SDP Program is to evaluate the significance of one particular plant degradation. And, I guess, it's in their -- therefore, I guess to combine events will not be useful for that purpose.

MEMBER APOSTOLAKIS: Well, I mean what they're saying, Mike, is we declare what we do to be the right thing. No, I'm really clear. We have to go back and find that recommendation --

MR. CHOKSHI: We will also go back.

MEMBER APOSTOLAKIS: -- because we did get a response that agreed with us. That was one of the few cases where the EDO agreed with us.

VICE CHAIRMAN SHACK: Although I must confess in my experience in working with the staff on SDPs in certain situations, I think they're very narrowly focused on the exact condition that was found.

MEMBER APOSTOLAKIS: Because maybe there was no other condition response.

MR. CHOKSHI: But I think in part, you know, the RASP Program, it is trying to get some of the differences ironed out and lead to some standardization.

I think rather than spending too much time, I'm going to turn it over to Gary. And, you know, he will start with the ASP plans. And, I think, a number of questions might be answered during that discussion.

MR. DeMOSS: Good morning. I'm Gary DeMoss, ASP Analyst and tasked with presenting the Davis-Besse -- the grid LOOP but first the results and insights of trends that we presented to the Commission in SECY-04-210 last November.

In SECY-04-210 we reported there were no significant precursors in FY 2003 or 2004. Davis-Besse was a significant precursors in FY 2002.

At that time, we reported that there were ten important precursors during the 2001-2004 time frame. And we characterized that as being based on preliminary data. The important precursors were three at Point Beach due to a design deficiency in the auxiliary feed systems and failure to correctly implement design changes.

Additionally, Davis-Besse was greater than ten to the minus fourth and a 2003 Palo Verde LOOP was ten to the minus fourth. The other five were based on the preliminary analysis of the northeast grid disturbance. Now as we approach the completion of the final analyses, we're now getting less than ten to the minus fourth for all of them due to some data changes in the SPAR model that we're going to talk about later.

There was no significant trend in the rate of occurrence of precursors during the period from FY 1993 to FY 2002. Mike, you've given the next slide. I'm going to speak to this a little bit. This would be different if we took the trend back further than ten years, as you can see from the chart here.

To go through this chart, you can see in the maroon color, the late '80s and 1990s, the number of precursors per year was quite a bit higher. The current ten-year period as trended is in the light blue.

VICE CHAIRMAN SHACK: Now are those corrected for what Mario and Steve claim was your extreme conservatism in the old days? Or, you know --

MR. DeMOSS: The answer --

VICE CHAIRMAN SHACK: -- is part of this transient due to the fact that your modeling has improved?

MR. DeMOSS: That's one of the possible effects here. We don't -- we have a policy to not go back and re-quantify old events with newer models. There's no particular value to it. So I think that is a contributor. Another major contributor is reduction in trip frequency in general. And so I think it is safe to say some of this is licensee performance.

We'll be looking a little more into that in a more detailed study we're going to start on trends.

MEMBER APOSTOLAKIS: Now which precursors are you reporting here? All of them? What condition or probability?

MR. DeMOSS: This is a number of precursors with the conditional probability greater than ten to the minus six. We reject anything less than ten to the minus six.

MEMBER APOSTOLAKIS: One would question even something like the standard of minus five. I mean why do I care, right?

MR. DeMOSS: We certainly tabulate that also. And I'll show it to you on the next slide.

MR. CHEOK: Well, I would kind of like to respond to what you just said, George. I mean if you look at the base PRAs for a lot of plants, significant events tend to be in the ten to the minus five range. So I guess we cannot say why do we care.

MEMBER APOSTOLAKIS: Significant in what sense?

MR. CHOKSHI: In other words, when we say these are significant scenarios. In the IPD space, we are told that we need to identify significant scenarios.

MEMBER APOSTOLAKIS: But remember these are conditional probabilities.

MR. CHOKSHI: That is true.

MEMBER APOSTOLAKIS: So presumably the unconditional frequency of the sequence is well below ten to the minus five.

MR. CHEOK: That's true.

MEMBER ROSEN: I have a question. I don't understand. You named five events. Three at Point Beach, the Davis-Besse, and one other, the Palo Verde event --

MR. CHEOK: Right.

MEMBER ROSEN: -- as being particularly significant. But if you multiple .1, which is the bottom line of precursors per reactor year times the number of reactor years, which is about 100 per year, times .1 is about 10. Then you get about -- you should expect to be told about 10 per year. And yet you only told us about five.

Now am I getting things mixed up here? I don't --

MR. CHEOK: I think what Gary was talking about, those five events you are talking about, is what he called important precursors which were ten to the minus four and above precursors.

MEMBER ROSEN: Oh, oh, oh.

MR. CHEOK: These are all precursors which are ten to the minus six and above.

MEMBER ROSEN: Oh, okay. Fine. Thank you very much.

MR. DeMOSS: Okay.

MEMBER APOSTOLAKIS: So, again, why are some of them historical and the others are final?

MR. DeMOSS: Well, we use the last ten years for all of our trending studies rather than a much longer term. I think we get into irrelevant data if we go back any further than that.

MEMBER APOSTOLAKIS: I don't understand that. The data from '95, they're not historical?

MR. DeMOSS: The word historical means that they are far enough in history back that we don't use them in our trending.

MEMBER APOSTOLAKIS: Oh.

MR. DeMOSS: And really nothing more.

MEMBER APOSTOLAKIS: So the maroons are not part of the trending?

MR. DeMOSS: They're not part of the trending analysis but I thought interesting to include on this slide.

MEMBER APOSTOLAKIS: So the year '97 was the best?

MR. DeMOSS: Ninety-seven was a good year apparently.

MEMBER APOSTOLAKIS: It was a very good year.

(Laughter.)

VICE CHAIRMAN SHACK: Not a great one but a good one.

MR. DeMOSS: Now I'll cover it on the next slide. I guess the other --

PARTICIPANT: In the white portion of the bars in '01 or '02 indicate --

MR. DeMOSS: That's -- the other interesting portion of this is that we have some CRDM cracking events mostly from DMW plants. And we haven't been able to quantify the initiating event probability, the ejection in a way that we can use for the ASP calculation.

This chart shows them assuming that they are precursors. I think they probably would be depending on the calculation.

The one important thing about that is another possibility is we'll decide not to spend the resources to do that, to do the difficult metallurgical calculations and classify those as events that we just can't analyze probabilistically and there have been a lot of those throughout history.

MEMBER APOSTOLAKIS: But let's not forget that, you know, this may be encouraging if you see the trend going down, of course. But still, all it takes is one of these events to create a problem, right. So let's not forget that.

MR. DeMOSS: Certainly, certainly. That's why we're keeping them alive. Certainly, the possibility is not trivial.

All right. Here's a little more detailed trending of the events of the last ten years. And, again, these slides are taken from the SECY. Starting at the upper left, the significant precursors, which is just one per year here we show in the last ten years are the Wold Creek drain down even in 1994, the Catawba LOOP in '96, and the Davis-Besse event.

MEMBER APOSTOLAKIS: And you have reports on each one?

MR. DeMOSS: And we have reports on each one. The Davis-Besse recently released.

MEMBER APOSTOLAKIS: Yes, we --

MR. DeMOSS: And the other two have been available for a long time.

MEMBER APOSTOLAKIS: What were the other plants? I'm sorry.

MR. DeMOSS: The first bar, the 1994 is the Wolf Creek drain down while shut down.

MEMBER APOSTOLAKIS: Wolf Creek.

MR. DeMOSS: The second bar, the '96 bar, is a LOOP at Catawba where a diesel generator breaker failed.

MEMBER APOSTOLAKIS: Yes.

MR. DeMOSS: And then 2002's data.

MEMBER APOSTOLAKIS: Thank you.

MR. DeMOSS: Again, this is not enough data to trend as you would expect.

MEMBER APOSTOLAKIS: But let me ask another question. You know I'm always -- I'm a little concerned about this ten to the minus X. No matter what happens in the world, we're always at very low numbers. How certain are you about this ten to the minus six? How high could it be? Reasonably high?

I mean even if something really bad

happens and we have editorials in the newspapers and so on, still the condition of probability is one in a thousand? This is a remarkably robust system. How high could this be?

MR. DeMOSS: Well, I mean we've had -- since '69, we've had three precursors greater than ten to the minus one.

MEMBER APOSTOLAKIS: One?

MR. DeMOSS: One of them was one, obviously.

MEMBER APOSTOLAKIS: No, but ten to the minus three, what kind of uncertainty do you have around that?

MR. DeMOSS: Well, the uncertainty is roughly an order of magnitude. Around a little bit more than that for Davis-Besse. And we'll display that later.

MEMBER APOSTOLAKIS: So even with Davis-Besse, it was still in the one in a hundred condition of --

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: -- probability.

MR. DeMOSS: Six to the minus three is --

MEMBER APOSTOLAKIS: Wow.

MR. DeMOSS: Well, the LOCA mitigation

systems were available with some deficiencies but not -- and, again, years ago, significant precursors were more common. We've had 26 since 1969. But relatively few lately.

MEMBER BONACA: That's an important observation, however. I mean the number is low, you know, thinking of core damage. But the point you were making, the ECCS was available so a significant contribution to the low number is that you have --

MEMBER APOSTOLAKIS: But this raises another question in mind. I mean sure the CCDP is a very important metric but should that be the only one we are looking at?

MEMBER BONACA: Because, I mean, the significance of --

MEMBER APOSTOLAKIS: I mean how close were we to having a LOCA?

MEMBER BONACA: Right.

MR. DeMOSS: Well, we'll try to explain that when I get to the Davis-Besse.

MEMBER APOSTOLAKIS: Yes, but I mean you could do it in general.

MR. DeMOSS: Although we won't be emphasizing the metallurgy in this one, we'll be talking about --

MEMBER APOSTOLAKIS: Okay, okay, okay.

MR. DeMOSS: -- the probabilities.

MEMBER APOSTOLAKIS: You know but do you understand my point? That CCDP is not necessarily the metric -- the only metric of interest.

MR. DeMOSS: That's right.

MEMBER APOSTOLAKIS: The conditional probability of having an initiating -- a serious initiating event would certainly be something of great interest it seems to me.

MR. DeMOSS: Well, and that's included. Since this was a condition --

MEMBER APOSTOLAKIS: It's included but not reported here.

MR. DeMOSS: Not here, no.

MEMBER APOSTOLAKIS: I know you're doing it because in order to get here, you have to do the other thing, right?

MEMBER BONACA: It's an important observation.

MEMBER APOSTOLAKIS: Right.

MEMBER BONACA: The owners -- at times, you know, I mean you look at the bottom line of the number and you say well, you know, yes, but again, you have to worry about the event itself.

MEMBER APOSTOLAKIS: Of course.

MEMBER BONACA: And if you come down to --

MEMBER APOSTOLAKIS: Think of the consequences of actually having the LOCA.

MR. DeMOSS: Well --

MEMBER APOSTOLAKIS: Yes, you don't need to go to core damage.

MR. DeMOSS: Well, no, the consequences to the plant are very significant.

MEMBER APOSTOLAKIS: Or the industry.

MR. DeMOSS: And to the industry, that's right. That we can't measure with our tools.

Okay. Going through these -- the ten to the minus four events, as shown, are showing a decreasing trend but not a statistically significantly trend. You can see the line there.

Again, we have had one more that is not on this graph which is the Palo Verde event of 2004. Again, that's still preliminary but likely to stay in that range.

The ten to the minus five bin, which is obviously a more common occurrence to get a ten to the minus five precursor is statistically significantly decreasing over the last ten years as shown by the curve.

An interesting thing and I'm not sure why is the number of ten to the minus six bin of events is increasing. And that is statistically significant.

MEMBER DENNING: Let me speculate and see what you think. Could that be the result of less conservatism in the SPAR models? That things we had been interpreting as being a higher probability, as you get more realistic in the SPAR models, may move down into the lower -- is that possible?

MR. DeMOSS: Yes. That's possible. And, in fact, we're going to start a study and I'll have a slide about that later that's going to look at that and a variety of other things.

And I think that and increased event identification by the SDP are going to be the reason for that rather than any performance. But that's my personal speculation on a study that hasn't started yet.

Okay. Moving on to the next slide which talks about what we're going to do. We are starting about now a detailed study into the trends and, in fact, the former ASP project manager is going to lead that study. And, you know, the trends that we have are -- the major trends we've noticed are precursors involving initiating events are decreasing. Again, that trip frequency-type thing.

Precursors involving conditional unavailability of equipment may be increasing. That's that ten to the minus six increasing trend. Precursors involving loss of offsite power are increasing recently.

MEMBER APOSTOLAKIS: So, I'm sorry, why do you talk about the conditional unavailability of equipment and not the conditional probability of having an initiator? Is that covered in the first bullet?

MR. DeMOSS: Well, the first bullet is actual initiating events. When we model --

MEMBER APOSTOLAKIS: Okay.

MR. DeMOSS: -- the conditional unavailability of equipment, we use the nominal probability of an initiating event for the period the condition that the equipment was unavailable.

MEMBER APOSTOLAKIS: Okay. All right.

MEMBER ROSEN: Does the second bullet imply that the unavailability of equipment is increasing in the plants? Because that's counterintuitive --

MR. DeMOSS: I mean that's one possible conclusion. I don't think that's the one we're going to come up with though. I think we're detecting it and reporting it more rather than we're really seeing more unavailability of equipment. But I think with a study we could begin to identify that.

MEMBER ROSEN: That's counterintuitive to my experience -- that over time, unavailability with the maintenance rule programs in place now, generally decreases slowly. Now I can provide one explanation of why this could be true and that is more plants are taking equipment out of service under (a)(4), 5065(a)(4) than previously, do maintenance while they're online.

MR. DeMOSS: Right. We wouldn't pick that up in the ASP Program because that's not a conditional unavailability due to a failure or anything like that. That would be picked up in some data work we do and monitored by NRR.

We would look to see if something was out during an equipment failure at that plant and maybe we would start seeing that. But that would be a kind of a random luck chance to really catch a problem there.

MEMBER SIEBER: It seems to me that, you know, we look into the future to a situation where risk information will be used to potentially liberalize a lot of outage times for pieces of equipment. It seems to me that you have to answer this question first before one treads down the path of allowing more outage time because obviously, it will have an impact on event frequencies and mitigating strategies and potential results.

And so I think this work is pretty important but you have to answer that question.

MEMBER ROSEN: Jack, that's a good point. What we're going to be faced with pretty soon is the risk management tech specs.

MEMBER SIEBER: That's right.

MEMBER ROSEN: Changes to tech specs based on risk that with varying lengths, depending on the risk significance of equipment. And that's coming down the pike.

MEMBER SIEBER: That's right. That's right. It's on our agenda.

MEMBER ROSEN: Yes.

MR. CHEOK: I guess and we will know more when we finish the study but I think from what we've seen so far, we do not believe that it could be an equipment licensee performance issue. It could be an identification versus a current rate issue.

In other words, starting in 2000, for example, we have the SDP and if you note that in the

ASP Program, we used to identify events based on LERs. Starting in '02, a bigger percent of our events are coming from SDP inspection reports, 20 to 30 percent.

Recently, we have increased our technology whereby we're now analyzing most if not all events. In the past, we had a category called impractical to analyze, which we did not analyze. So we are looking at maybe a case where we are now identifying more events as opposed to the events occurring more often. So we will have to come to a better conclusion with respect to that.

MEMBER SIEBER: Yes, right now what you're telling us is your speculation. And what we're trying to do is encourage you to change that to something with a little more firmness.

MR. DeMOSS: Okay. Just other preliminary information to set the stage for this next study is that we haven't seen any apparent trend related to plant type, the BWRs and PWRs appear to be behaving about the same.

We've noticed there are some years, like somebody pointed out, 1997 was a particularly low year and 2004 looks like it might be. We'll look into why some of the things fluctuate and we'll look at causes of precursors as opposed to just occurrences.

The contribution to these trends, and we're going to try to map these contributions up to this list of trends are -- and see where they fit -- is introduction to significant determination process and its maturation, revisions to the SPAR models. They've gone from a very simplified model to a detailed PRA.

Possibly changing licensee performance, we're going to look for it. Plant aging, we'll look for it to see if something comes out in our data. Industry and NRC initiatives may attribute to some of it and possibly the maintenance rule, we're looking for that.

Look for outliers in plant performance. Several plants seem to be padding the ASP statistics a little more than others. And we'll try to identify that and make a conclusion.

Changes in ASP screening criteria and analysis methodology, the program has evolved some and we'll see what the effects of that are.

And we're also going to look at the ASP Index which is shown here on the next slide. And the ASP Index is calculated by adding the total conditional core damage probabilities of all precursors in a year and dividing it by the total number of reactor years for that year. And so the chart looks fairly similar to the -- at a first glance to the number of precursors per year. But a little closer look and we start to see that it's heavily driven by significant precursors, remembering a significant precursor is a one to the minus three or above event and now this chart shows it divided by the roughly 100 reactor years.

Again, we include the older data as well as the last ten years which is really what we'll be focusing on. But you can see the spikes in '94 and '96, the years of significant precursors. And another spike in '02 due to the Davis-Besse event.

MEMBER APOSTOLAKIS: I'm -- I think maybe I don't fully appreciate what you're presenting here but it seems to me we're spending too much time looking at statistical information which, I don't know -- it has some value to it by why do we really care about all these trends?

I mean it seems to me we should be learning more about what is actually happening, what the ASP is telling us about --

MR. DeMOSS: And that's -- I think that's where need to go with this study as I described on the last slide. We're missing the whys. And all we've reported is these trends. And -- you're right.

MEMBER APOSTOLAKIS: I mean what can Agency do with this? This particular slide, what -- can you go to the Commissioner and recommend two or three decision options given this within you can do A, or B, or C. Or is it just it makes us feel good?

MEMBER POWERS: George, isn't it a question that everybody is going to ask?

MEMBER APOSTOLAKIS: Sorry?

MEMBER POWERS: I mean even if you can't act on it, isn't it a question that people are going to ask? You're going to have the answer in your pocket no matter what.

MEMBER APOSTOLAKIS: What question is that?

MEMBER POWERS: You know, with the trends.

MEMBER APOSTOLAKIS: Yes.

MEMBER POWERS: Are we getting better or worse?

MEMBER SIEBER: Yes, how are we doing?

MEMBER POWERS: They're always going to ask that question.

MEMBER APOSTOLAKIS: Okay. So you can have one slide. I think we're spending too much time. It's a matter of emphasis. It seems to me what actually happened -- I mean are the human errors increasing? What kinds of human errors? Under what conditions? Do you have any slide on these things?

MR. DeMOSS: No, we don't.

MEMBER APOSTOLAKIS: You see, that's my point. It's a matter of emphasis. I'm not saying that this is useless but it's just a matter of balance.

And you are in a unique situation to give us insights regarding these things.

MEMBER ROSEN: What's the far right? W/O mean on this chart?

MR. DeMOSS: Oh, that's without the Davis-Besse event in '02 to show the difference with and without the event just to show how a significant precursor --

MEMBER ROSEN: Just for that one bar, '02?

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: Don't misunderstand me. I'm not saying this is not useful. It's just that I think that the balance is not right.

MR. DeMOSS: Okay. I'm agreeing with you. I can't disagree with that. And that's where we're going.

MEMBER SIEBER: Why don't we move forward.

MR. DeMOSS: Yes, okay.

MEMBER APOSTOLAKIS: We really have to go to Davis-Besse because --

MR. DeMOSS: Yes, well, okay.

MEMBER APOSTOLAKIS: -- that will answer a lot of my questions.

MEMBER SIEBER: The time is right.

MR. DeMOSS: Yes, you're right. We are falling behind our planned time here. And this slide simply summarizes that major points that we've discussed for the last 20 or 30 minutes here. And it introduces the fact that we're going to spend the rest of the presentation on the unique condition at Davis-Besse.

The Davis-Besse event we strove to develop an analytic approach that would give a realistic integrated risk analysis of the three conditions that existed at Davis-Besse. A construct of the ASP Program as we only treat them for the year that they existed. They actually probably existed quite a bit longer.

One condition was latent debris in containment caused unqualified coatings, uncontrolled fibrous materials and other debris that could clog the ECCS sump following a LOCA. We drew heavily on the work from GSI-191 to quantify the probabilities associated with sump performance.

The second condition we included in this is a design deficiency in the high-pressure ejection pumps that would cause pump failure during a recirculation mode.

MEMBER APOSTOLAKIS: Latent debris, is that the property? I guess nobody else is --

MR. DeMOSS: That's the stuff that you're leaving in the containment.

PARTICIPANT: Right. It's just junk.

MEMBER APOSTOLAKIS: It's latent?

MR. DeMOSS: Yes, concrete, dust --

MEMBER APOSTOLAKIS: I understand what it is.

MR. DeMOSS: Dust bunnies and concrete dust.

MEMBER APOSTOLAKIS: I just wondered whether this is the proper English. Is it the proper English?

MR. DeMOSS: That's the word used in the LER.

MEMBER APOSTOLAKIS: Oh, then it must be right, okay. Latent debris, wow.

MR. DeMOSS: But it is -- okay. Testing

and analysis proved that the high-pressure recirculation would fail due to a bearing that is cooled and lubricated by process fluid at Davis-Besse. And it's a unique situation to their high-pressure injection pumps.

VICE CHAIRMAN SHACK: Very unique. I think when I asked the question, no other plant has a high-pressure injection pump like that.

MR. DeMOSS: I asked the same question. I was told that is true so --

VICE CHAIRMAN SHACK: Okay.

MR. DeMOSS: And the final condition is, of course, the head, which was CRDM nozzle crackage and leakage that led to a cavity formation and could have resulted in a LOCA.

To quantify these risks, we use an expert elicitation to determine the distribution of possible conditions to the head a year prior to discovery. And we also used these same group of experts, metallurgists, to determine the degradation rates.

DET and their contractor created a Monte Carlo analysis of alternate scenarios to determine the possibility of failure and the failure mode and output the LOCA probabilities I need for an ASP model.

MEMBER APOSTOLAKIS: So these are your

References 11 and 14 in the report, which I would like to get a copy of.

MR. DeMOSS: Okay. I'll take your word on the reference numbers, but yes.

MEMBER APOSTOLAKIS: They are.

MEMBER SIEBER: Just give him what he asks for.

MEMBER APOSTOLAKIS: Because every time I went to somewhere where I thought I was going to learn something, it says but this was done in Reference 14.

MR. DeMOSS: Okay. Yes.

MEMBER APOSTOLAKIS: So somebody -- let me understand that -- somebody said the conditional probability of getting a small or medium LOCA given what we have observed --

MR. DeMOSS: Given the degradation --

MEMBER APOSTOLAKIS: -- is such-and-such --

MR. DeMOSS: Right.

MEMBER APOSTOLAKIS: And how did they do that?

MR. DeMOSS: That's a two hour presentation in itself.

MEMBER APOSTOLAKIS: No, no, but you can summarize it.

MR. CHOKSHI: I think that we have one or two slides.

MR. DeMOSS: Right. We have a couple of slides next.

MEMBER APOSTOLAKIS: Okay.

MR. CHOKSHI: That was part of my work.

MR. DeMOSS: And we've got a couple of brief slides to describe quite a bit of work that was done by the metallurgists here. The metallurgists --

MEMBER ROSEN: You skipped over the last bullet on the last slide which is also of quite a bit of significant interest on how one can estimate the probability of control rod ejection given the circumstances at Davis-Besse.

MR. DeMOSS: And that's --

MEMBER ROSEN: And that was a nozzle rejection.

MR. DeMOSS: Yes, that's a nozzle.

MEMBER ROSEN: Is that part of what you're going to tell us about?

MR. DeMOSS: We're going to tell you just briefly about that. Again, it's not a detailed presentation. It's a model. And actually Dr. Shack was involved in developing it.

MEMBER APOSTOLAKIS: You just shut him out of the discussion.

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: But let me -- is this Committee interested in having actually an information briefing on the Davis-Besse analysis? I would like to see that.

MEMBER ROSEN: That might be a good idea. But let's hear some more before we decide.

MEMBER SIEBER: Yes. But we can't do that today.

MR. DeMOSS: No, we're going to go rapidly through these slides.

MEMBER APOSTOLAKIS: But do you remember roughly what the relative probabilities of the three LOCAs were?

MR. DeMOSS: Yes. The total was about 20 percent chance of a LOCA in the construct we made. And about 18 percent of that was a small LOCA generally due to the crack opening up.

And then in rough figures, the medium and large LOCA were each one percent -- the medium driven by the CRDM nozzle ejection and the large LOCA driven by the upper end of possible degradation of corrosion rates, I should say, to unback a larger piece of cladding.

MEMBER APOSTOLAKIS: So the medium and large were equally likely?

MR. DeMOSS: Roughly.

MEMBER ROSEN: And is the consequence of those in your study also?

MR. DeMOSS: Oh, absolutely.

MEMBER SIEBER: Corrosion was occurring at a rapid rate.

MEMBER ROSEN: So the consequence --

MEMBER APOSTOLAKIS: But every time people talk about this, they talk about the medium LOCA. Now this is news to me.

MR. DeMOSS: Well, this is because you've got the hole in the head. You know losing the nozzle is a medium LOCA.

MEMBER SIEBER: That's right.

MR. DeMOSS: The hole in the head --

MEMBER ROSEN: But my question about the sequence --

MR. DeMOSS: Well, the accident -- right, if we were to have a large LOCA, the probability of core damage is much larger than if we were to have a small LOCA. The PRA models basically automatically take care of that.

MEMBER ROSEN: Sure. But I'm not -- I'm

interested in what happens to the control rod drive mechanism itself. Is that analyzed to be ejected? The rod is actually ejected? And there's a reactivity addition because of that?

MR. DeMOSS: Right. But the analysis says that that's not an atlas -- one ejection is not an atlas issue.

MEMBER ROSEN: Okay. But you do take the analysis out through the reactivity effects of a rod ejection under these conditions?

MR. DeMOSS: The answer a general no because the reactivity addition is not an atlas. And so for the risk sequence, we're aren't getting an atlas condition.

MEMBER ROSEN: Well, I think, George, now I'm interested enough --

MEMBER APOSTOLAKIS: Yes, me, too.

MEMBER ROSEN: -- to have --

MR. CHOKSHI: Yes, okay. So let's plan it.

MEMBER APOSTOLAKIS: It would be extremely informative actually.

MR. DeMOSS: I mean that was analyzed.

MEMBER APOSTOLAKIS: We should do this in the near future. Michael, are you taking notes of this?

MR. SNODDERLY: Yes, sir.

MR. DeMOSS: All right. The DET and the contractors did quite a bit of analytic work and laboratory testing to understanding the situation at Davis-Besse.

They had three objectives in their study. One was to assess the structural integrity of the primary coolant pressure boundary for the conditions exactly as existed on February 16th. In other words, what was your margin at that point.

The other was to see how much longer Davis-Besse could have gone if it were undetected and not taken off line in February 2002.

And the third was in support of the ASP Program to go back a year and then hypothetically quantify what alternate scenarios in metallurgy, corrosion, and cracking rates could have lead to a LOCA on or before February 16th, 2002.

MEMBER APOSTOLAKIS: That was pretty good. I like what you did there. Don't be shocked. We don't always criticize.

(Laughter.)

MR. DeMOSS: Many aren't thrilled with that.

Okay. And this slide shows a brief overview of the methodology used for the three calculations. And, again, not going into much detail, they did a geometrically accurate and complete analysis of the as-found condition.

MEMBER APOSTOLAKIS: Geometrically accurate? This is like latent debris?

MR. DeMOSS: Right. In other words, they didn't use a circle or a simply football shape or something like that to quantify it. They actually did the finite element. And you're out of my league here real quickly because I'm not a metallurgist. A finite element analysis.

They then used that to tune a model that used simplified shapes and then incorporated the corrosion and crack growth rates for the forward-looking analysis, how long would it last, and the ASP analysis, the backward-looking method. And it is interesting.

Okay. The key findings -- and I think they're all important -- are, of course, there is no failure by the day of discovery and, in fact, there was a factor of about one and a half safety margin on the operating pressure. And still a significant amount from a relief value set point pressure at the time of discovery.

Using their Monte Carlo simulation, their best estimate for the median time of continued operation for failure is about five months. And there's a large uncertainty in that because this is kind of a non-standard groundbreaking metallurgic analysis.

You basically have a horse race between the corrosion growing, the unbacked cladding area, and the crack growth rates within the cladding.

VICE CHAIRMAN SHACK: But you loss with both races.

(Laughter.)

PARTICIPANT: Which one won the race?

MR. DeMOSS: The other participant was the licensee and the NRC that shut the plant down and put a new head on.

MEMBER APOSTOLAKIS: Wait a minute.

MR. DeMOSS: So we won.

MEMBER APOSTOLAKIS: You're on the second bullet, right?

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: Approximately five months with large uncertainties so what does that mean? How large is it?

MEMBER SIEBER: It's plus or minus five.

MR. CHOKSHI: I think it is a very complex, you know, with cracks and the assumptions you make length of the crack, the depth of the crack, whether it is a continuous crack --

MR. DeMOSS: Yes.

MR. CHOKSHI: -- what the core requires. So based on all of these different conditions of basic knowledge and on the median estimates, it went from five to 13, Allen? Or would you say five was the lower boundary?

MEMBER APOSTOLAKIS: Wait a minute. Five is the median.

MR. CHOKSHI: Yes. These are median estimates. Median estimates range from five to 13 months depending on different assumptions.

MEMBER APOSTOLAKIS: So this number there is the low bound?

MR. CHOKSHI: Then I will let Allen then give the accurate numbers.

MR. HISER: I'm not sure if I can give accurate numbers but --

MEMBER ROSEN: Allen, could you --

MR. HISER: -- maybe explain a little bit.

MEMBER APOSTOLAKIS: Who are you?

MR. HISER: I'm Allen Hiser, Materials Engineering Branch in Research.

One of the biggest uncertainties was that there were cracks identified in the cladding and how one models those has a big impact on who loses the race earlier.

The five months relates to using an ASME code type of definition for the cracks. So looking at the largest extent of the cracks and the deepest crack, modeling that as the overall crack geometry provides you with a five month.

I believe eight months is the same length of crack but a shallower depth that more represents the average, I believe. About 13 months would represent a shorter crack with the same average depth. So there are a lot of parts of the analysis that are really driven by the assumptions.

MEMBER APOSTOLAKIS: Oh, absolutely.

MR. HISER: And the cracks are one part.

MEMBER APOSTOLAKIS: So what is the range? Five to 13?

MR. CHOKSHI: Five to 13.

MR. HISER: Five to 13 would be a 50 percent failure.

MEMBER APOSTOLAKIS: So this bullet is not quite right?

VICE CHAIRMAN SHACK: You've just talked about the cracks, Allen. How about the, you know, eroding away the materials?

MEMBER APOSTOLAKIS: Did you say five to 13 or would you say the best estimate between five and 13?

MR. HISER: Yes.

MR. DeMOSS: Well, no, there are two separate medians to two separate approaches to the analysis are the five and 13. Is that stated correctly?

MR. HISER: Yes, the five and 13 just related to whether you assume an ASME-type crack or you assume a less severe crack.

MEMBER APOSTOLAKIS: No, but, you see, the way it is stated it says the median is five with a large uncertainty. So my mind says -- in my mind, oh, so it could be as low as one?

MEMBER BONACA: Absolutely.

MEMBER APOSTOLAKIS: See, it's not stated well.

MEMBER BONACA: Yes, I'm just puzzled --

MEMBER APOSTOLAKIS: A median between five and 13 or the best estimate of the median is eight.

MEMBER BONACA: Yes, just I have a question regarding this. If I understand it, I mean the issue as identified by the fact that as they were working on the head, the nozzle simply fell off, right?

MEMBER SIEBER: Fell over. It tipped over.

MEMBER BONACA: So that gives me a picture of, you know, instability that is inconsistent with some of the estimates here. It seems as if this thing was ready to just fall off.

MR. HISER: Yes. Let me clarify one part. It -- when they took the head off the vessel, the nozzle was still secured by the J-groove weld. It tipped when they were doing repairs of the nozzle. So at that point, they had, in effect, machined out the entire J-groove weld. So there was nothing to support the head or to support the nozzle.

MEMBER KRESS: Does the growth of the crack until it penetrates the head result in a small break LOCA, a medium break LOCA, or what?

MR. HISER: If the crack grows through to the point that you have an unstable ligament in the cladding, then you would get a small break LOCA, I believe.

MR. DeMOSS: I think there was a -- they had a failure parameter in that Monte Carlo that could have gone to small or medium in that case but almost all of them, as I recall, went to small.

MEMBER KRESS: Went to small? That's what I was going to say.

MR. CHOKSHI: And, you know, some testing was done to basically pin down what kind --

MR. DeMOSS: Yes, I think there was some possibility that the crack could fish-mouth wide enough coupled with maybe a high corrosion because that was in the bin, too, that you could possibly go to medium that way.

MEMBER DENNING: What are minimum safeguards under that condition? Is that high pressure pump, is it critical in recirc for that? Or do you have other pumps that can still handle that condition?

MR. DeMOSS: Well, the large pumps are still available and working as well as the sump is available -- as well as the sump is working for recirculation.

MEMBER DENNING: And the pressure at that time would be such that the low head pumps would be effected you're saying in recirc?

MR. DeMOSS: The licensee would have to take action to depressurize for a medium.

MEMBER DENNING: They'd have to take action to depressurize?

MR. DeMOSS: Yes.

MEMBER SIEBER: Yes, the pressure would hang up then.

MR. DeMOSS: But it is proceduralized action. It's not heroic or anything like that.

MEMBER SIEBER: I think we're really falling behind.

MR. DeMOSS: We are. But we'll pick it up as best we can.

MEMBER SIEBER: It's just as bad for me as it is for you to say.

MR. DeMOSS: Okay. Again, as I've stated before in response to a question, we had about a 20 percent likelihood of a LOCA under the risk construct.

This slide shows the results of the analysis. And we're going to spend a minute on this one. And then we'll speed back up.

Starting with the upper left corner, you see a diamond. That's the best estimate of core damage probability. That's 60 to the minus three with the three conditions set at our best estimate for the sump parameter, the failure of the high-pressure recirculation pumps, and the LOCA probabilities.

The first error bar is our sensitivity to LOCA parameters. The metallurgists ran a large number of scenarios and assumptions through their Monte Carlo code to come up with LOCA probabilities. And then we ran them through the PRA models and came up with that range of answers.

This is not an uncertainty. It's a range of sensitivities. We don't really have the technology or it would have cost a lot more money to propagate uncertainties through the metallurgical model so that was not done.

MEMBER APOSTOLAKIS: Of course, you pay a price for that. I'll go to the microphone.

MR. DeMOSS: Okay. Again, in that time, we --

MEMBER APOSTOLAKIS: Isn't there a certain arbitrariness in the sensitivity studies?

MR. DeMOSS: Yes. That's inherent in any sensitivity study done by Monte Carlo analyses and --

MEMBER APOSTOLAKIS: So why do it then. I mean if there is a quantity that you think should be increased by a factor of four to see what happens, why not a factor of ten?

MR. DeMOSS: Well, the --

MEMBER APOSTOLAKIS: Somehow you have --

MR. DeMOSS: -- quantities in a metallurgic analysis had probability distributions on them. And they would change a Monte Carlo rule or metallurgical rule for that more than just changing quantities.

But the Monte Carlo analysis puts out, you know, repeated runs of scenarios through those probability distributions. And then you have what look like discreet results. So we don't try to establish a true uncertainty with that.

MEMBER APOSTOLAKIS: But you have some idea who likely these results --

MR. DeMOSS: Well, I think the sensitivity analysis, the way we did it, gives you some idea how uncertain you are about these results.

MEMBER APOSTOLAKIS: All I'm saying is that it is not very difficult to go the next step and actually say something about the distribution because deep in your mind or whoever did it, when they did the sensitivity, they had some idea that this is reasonable.

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: And since we are

elevating expert opinion elucidation to a science here, you know, that's the natural next step. Sensitivity analysis are remnants of the old way of doing business. Now that we're using probability curves, we should do it with probability curves.

MR. DeMOSS: Yes. You'd have to -- there's a lot of probability curves to propagate through that metallurgical analysis.

MEMBER APOSTOLAKIS: Oh, okay.

MR. DeMOSS: I don't know how difficult it would have been. It would have been --

MEMBER APOSTOLAKIS: I think Nilesh understands what I'm saying.

MR. CHOKSHI: I probably have to show you the, you know, those two reports -- what was done.

MEMBER APOSTOLAKIS: I know. There are statements there to the effect that the sensitivity analysis were done.

MR. DeMOSS: Okay. The next --

MEMBER APOSTOLAKIS: But we will have another briefing so we'll discuss it in far more detail.

MR. DeMOSS: The next bar is sensitivity to assumptions about how the sump would have performed. And with our LOCA probabilities and our high-pressure recirculation system set up at their best estimate values.

The sump was analyzed using the work of GSI-191. And remember most PRAs, including the SPAR models, have an epsilon value of R to the five e to the minus five value probability of a sump plugging in a LOCA. GSI-191's quantification is not really well along to come up with an accurate probability estimate but they, I think, clearly show it is not the near negligible value that is floating on the PRAs.

So what I did is take the basic PRA up to the best GSI-191 estimates for Davis-Besse. And then add a delta for their reported deficiencies in containment, their unqualified coatings, and debris in containment. And see what delta risk was brought up.

GSI-191 developed curves based on the solid debris, and the particulate debris, and the fibrous debris possibly in containment that could be mapped to a probability of containment failure. And there are different assumptions that could be used in going through those curves. And that's where I developed a different sensitivity cases for my analysis of the sump.

And you can see it was actually slightly more sensitive to sump failure assumptions than it even was to the LOCA assumptions. But they went together and that's not surprising because our dominant cut sets were medium LOCA and large LOCA followed by a sump plugging.

And finally we did a sensitivity to high-pressure recirculation system which was -- really focuses mainly on the small LOCA and it was not nearly as important.

As we move further to the right, we set -- we start verifying what SDP did and doing some other for instance calculations. The vessel head only calculation uses the same sensitivity analysis points for LOCA probabilities that we used earlier but the sump and high-pressure recirculation system are nominal.

The purpose of this is simply to show that the vessel head only would have given you a red finding. There was an SDP done for just the vessel head per our earlier conversation. And it was a red SDP.

The next one over is the CRDM only. The NRC, although they didn't have as sophisticated models as I had to work with for the CRDM LOCA probability, the NRC knew that there were CRDM problems. That's why they asked for a shutdown of the susceptible plants, mainly B&W plants.

So for a year with just the CRDM problem, we would have had a high ten to the minus five increase in risk for Davis-Besse.

The next calculation is to show how much risk we allowed or we incurred by allowing Davis-Besse to operate the additional six weeks. They received special permission to not shut down by the first of January and to operate about six weeks until December. And you'll see we've added a -- I think it was about eight times ten to the minus six delta risk by operating that long.

VICE CHAIRMAN SHACK: If you only had the CRDM finding --

MR. DeMOSS: If we only had the CRDM and that's based on the premises that, quite frankly, NRC really couldn't have expected the other problems. And so those values were nominal in my risk model.

VICE CHAIRMAN SHACK: The other problems being the high-pressure injection and sump?

MR. DeMOSS: The high-pressure injection, the sump, and the cavity. All three were essentially unpredictable. And, you know, the two were caught during the shutdown. And the vessel head was discovered.

The next one is just a for information run. And as we go to the right of the line, we reset our LOCA frequencies back to nominal. And so this is done for the purposes of checking the SDP runs and to make sure that we're modeling the same way and that sort of thing.

And the first one is not an SDP analysis because it has two degraded conditions in it, the HPR and the sump simultaneously degraded. That shows that risk estimate.

We then run the sump failure probability through with nominal LOCA frequencies and you see you get no worse than about a ten to the minus five increase in risk. So that's what we're getting probably at most plants due to sump problems.

MEMBER DENNING: I'm missing something and that is these are conditional probabilities here. Now when you go and you use nominal LOCA frequencies, are we still dealing with a conditional probability? Or are we dealing with an annual --

MR. DeMOSS: We're calculating a conditional probability still. Actually at the delta CDP due to just the sump problem. With everything else at a nominal good likelihood.

CHAIRMAN WALLIS: Now wait a minute. You

mean that the sump only contributes D to the minus five?

MEMBER SIEBER: Yes.

MR. DeMOSS: Correct. Alone. Remember they're multiplicative, not additive, especially these three conditions, which is why they come up to such a high risk together. And relatively low risk --

VICE CHAIRMAN SHACK: Is that a delta CDF -- you've multiplied the conditional by the nominal LOCA frequency to get the ten to the minus five?

MR. DeMOSS: Correct.

CHAIRMAN WALLIS: That's where I was trying to get at. I mean most of the low -- the reason that it is so low is because of the nominal LOCA frequency.

MR. DeMOSS: Right. So if this were at another plant --

CHAIRMAN WALLIS: The conditional probability for the sump is way up there, right?

MEMBER DENNING: I'm still missing the units. It still looks to me like this is per reactor year on the right.

MR. DeMOSS: It is.

MEMBER DENNING: But on the left it's not.

MR. DeMOSS: No.

MEMBER DENNING: That's conditional.

MR. DeMOSS: It's the same units on both places. They're both delta CDPs, which is the increase in core damage probability over a year since our construct has us doing this analysis for a year.

MEMBER DENNING: Now wait a second. Over a year -- I'm missing -- these over here are not over a year. This is conditional on -- isn't it?

CHAIRMAN WALLIS: No, it's not conditional.

MR. DeMOSS: They're conditional on the problems.

MEMBER DENNING: Yes.

MR. DeMOSS: But the increase is the delta core damage over a year because we didn't actually have an initiating event. We calculated pure conditional probability --

MEMBER DENNING: For a year?

MR. DeMOSS: -- following an initiating event. Here we -- but for a condition, a piece of equipment that the plant operating with -- operated while it was in a failed state, we calculate a delta CDP. In other words, we subtract out the baseline CDP, if you will, the unflawed CDP, during that period of time.

Now in a lot of ASP analyses, it would be a pump out for a month or something. This one was a condition that went undetected for a year.

MEMBER ROSEN: To nail down my understanding, let's take a plant with an annual CDF of 1.5 e to the minus five.

MR. DeMOSS: Okay.

MEMBER ROSEN: And let's just say it has the sump problem.

MR. DeMOSS: Right.

MEMBER ROSEN: That's the only problem it has. And is it now 2.5 e to the minus five?

MR. DeMOSS: That's correct.

MEMBER ROSEN: Okay.

MR. DeMOSS: So the delta CDP that I'm reporting here is one e to the minus five. That's the increase due to the problem. And that's what the SDP also calculates.

CHAIRMAN WALLIS: But the probability of the sump failing could be --

MR. DeMOSS: It's quite high.

CHAIRMAN WALLIS: -- pretty high.

MR. DeMOSS: Right.

CHAIRMAN WALLIS: It could be 22 or something.

MR. DeMOSS: Yes, GSI-191 told me it was better than .5 for a large LOCA.

CHAIRMAN WALLIS: Right. For a large LOCA it's almost one. It's getting up there.

MR. DeMOSS: Right.

CHAIRMAN WALLIS: Okay. That makes sense.

MR. DeMOSS: But large LOCAs with a good head is very unlikely. And even fairly unlikely with Davis-Besse's head.

Okay. So -- and again, this shows that it is consistent with -- the sump is conditioned with a yellow finding, the ten to the minus five, or the SDP. And the HPR was actually a white finding in the mid ten to the minus six range. And that is consistent with the SDP.

Okay. Running through the Davis-Besse results, it is a significant precursor. In all of history, there have been 11 ASP events higher than Davis-Besse. All of them occurred -- all the ones higher than Davis-Besse occurred in 1985 or before. We haven't seen anything like this in a while. We've had two other significant precursors in the last ten years, as I spoke earlier.

MEMBER APOSTOLAKIS: I'm having difficulty reproducing your 6.1 ten to the minus three in your report. There is a table there -- Table 1 that has a bunch of numbers. And I'm trying to figure out how this 6.1 ten to the minus three came about. And I can't.

So if we're going to have another briefing, maybe we can do that there --

MR. DeMOSS: Okay.

MEMBER APOSTOLAKIS: -- because this is until 10:30 and it's going to take forever if we are to do that. But by looking at the SECY, I cannot reproduce it.

MR. DeMOSS: From the SECY?

MEMBER APOSTOLAKIS: Well, whatever you call this.

MEMBER BONACA: The report you gave us.

MR. DeMOSS: Okay.

MEMBER BONACA: What is it? I mean you are so surprised.

MEMBER APOSTOLAKIS: The final precursor -- that's part of something. Now I just noticed that the infamous Reference 14 has Mr. Cheok as a coauthor. So maybe I can get the copy today? Right?

MR. CHEOK: I'm not sure what Reference 14 says.

MEMBER APOSTOLAKIS: It says Cheok.

Right? The mention of increase in medium LOCA frequency attributed to circumferential tracking potential in leaking CRDM nozzles.

MR. CHEOK: I think that's a memo --

MEMBER APOSTOLAKIS: A memo.

MR. CHEOK: -- to me. I can provide that to you.

MEMBER APOSTOLAKIS: Oh, it's a memo to you. Yes, I'm sorry.

But anyway, the number I cannot reproduce. Okay?

MR. DeMOSS: Okay. Well, I can either go with that individually or whatever you need.

MEMBER APOSTOLAKIS: Okay. And I'm really disturbed by the use of the word significant here. You haven't gone to the second red bullet. But DB had a significant loss of safety margin.

Then you're telling us that the margin could be as low as ten to the minus two. Ten to the minus two margin in my mind, after all these bad things have happened, is pretty good. If this is the worst thing that ever happens in reactor safety, I'll be very happy.

MR. DeMOSS: Well, by our calculations --

MEMBER APOSTOLAKIS: One in a 100. I mean think about it. That's a pretty low number.

MEMBER BONACA: For core damage.

MR. DeMOSS: For core damage, right.

MEMBER APOSTOLAKIS: Yes, for core damage.

MR. DeMOSS: But like I say we haven't been to one in 100 in quite a long time is the point I'm making.

MEMBER APOSTOLAKIS: Oh, well, that's different. That's unusual.

MR. DeMOSS: I'll let you interpret good or bad.

MEMBER APOSTOLAKIS: It's unusual.

MR. DeMOSS: Yes.

MEMBER APOSTOLAKIS: It's rare. But it's not significant.

MEMBER BONACA: Let me make the analogy that support this evaluation consider the hole in the head -- the thermalhydraulics, I mean.

MR. DeMOSS: Right. Who did the thermalhydraulics?

MEMBER BONACA: Yes.

MR. DeMOSS: NRR did it.

MEMBER BONACA: Yes, I'm saying did they consider the hole in the head for a small break LOCA?

MR. DeMOSS: Yes. They verified it was

bounded by the small LOCA recovery models in a PRA. And bounded -- it's actually a fairly good place to have a LOCA if you're going to have one.

You don't lose any of your injection flow and you have a steam leak, which are really the two driving criteria for that. So it's not too bad.

All right, again, getting back to the slide, the reason for the loss of safety margin, which is significant relative to other events we've seen in recent times, is the fact that you had three major problems at the same plant.

And, again, our sensitivity analysis show that we're clearly and well into the ten to the minus three or possibly ten to the minus two range. We're not lower than that or higher.

MEMBER APOSTOLAKIS: Could we skip the agreed portion, I think, and go to the SPAR models.

MEMBER SIEBER: Yes.

CHAIRMAN WALLIS: Let's see how does this number change if you wait longer? If this had waited for another few months --

MR. DeMOSS: Okay. ASP is always a backward-looking program so we didn't look at that. Certainly the likelihood of a LOCA would have been higher.

CHAIRMAN WALLIS: It would have been much higher?

MR. DeMOSS: Right. But by construct, we look at what risk we incur.

CHAIRMAN WALLIS: So how much of the -- you know we've got a multiplicative thing here. How much of the six times ten to the minus three is low because the pressure boundary was still likely to hold? Can you tell us that? How much of the contribution was from the pressure boundary?

MR. DeMOSS: Well, the main -- the contribution was the sum of all LOCAs. The dominant contributions were from a large LOCA, which is the tail of that distribution times the high likelihood of the sump failing in a large LOCA.

Another roughly equally dominant cut set was a medium LOCA which is --

CHAIRMAN WALLIS: Since the containment sump failure is high and that doesn't account for the six times ten to the minus three.

MR. DeMOSS: Well --

CHAIRMAN WALLIS: And the high-pressure injection system, is that a big contributor to this low number? Or is it just --

MR. DeMOSS: It's not a tremendously large contributor.

CHAIRMAN WALLIS: So it's really the fact that the pressure boundary was able to hold, which makes this thing so low? Is that what it is?

MR. DeMOSS: Right. The pressure boundary --

CHAIRMAN WALLIS: Okay.

MR. DeMOSS: -- did hold. If the pressure boundary hadn't -- I don't have a calculation and it would be a little tough to do off the top of my head for if the pressure boundary had failed with these other problems, it would be pretty likely. I mean we have a 20 percent chance of failing the pressure boundary. And most of that failure probability is a small LOCA.

But the medium and large LOCAs are about one in a 100. So forgetting about the small LOCA, we'd have something like a .6 if we had had one of those LOCAs. That's real rough. But you're getting above .1 certainly.

MEMBER DENNING: See there's an element of this that surprised me because I thought that what you were really doing -- I didn't realize that you were annualizing a probability when you did.

And I was thinking if we come and we have this condition, and if we hadn't done anything for however long it would have taken, if we hadn't recognized that condition, what is the probability we would have had core melt? Not on a change in a core damage frequency but a conditional probability core melt.

MR. DeMOSS: So in other words --

MEMBER DENNING: It's a different way of looking at it.

MR. DeMOSS: Right.

MEMBER DENNING: But in this case with a degrading condition where presumably eventually it would have blown one way or the other, it may give you a different perspective. And, you know, I'm kind of surprised because I thought that's what you really meant by a conditional core damage probability. And it isn't.

MR. DeMOSS: No. It's a conditioned analysis in other words.

MEMBER DENNING: It's conditioned analysis but --

MR. DeMOSS: Right.

MEMBER DENNING: -- it's still an annualized --

MR. DeMOSS: It's an annualized condition analysis with degraded equipment at the plant.

MEMBER DENNING: Yes, yes.

MR. DeMOSS: And one of the pieces of degraded equipment is the head.

MEMBER DENNING: But it doesn't look at -- suppose we had continued on for two years or three years? Does it lead to --

MR. DeMOSS: Well, it leads to --

MEMBER DENNING: -- core melt?

MR. DeMOSS: -- just doing the calculation in my head, if it went on -- if you let it run until it broke --

MEMBER DENNING: Yes.

MR. DeMOSS: -- and yet we don't know which break, there is a probability of each size of break, you're probably greater than .1 chance that we would have gone to core damage.

MEMBER KRESS: I'm having trouble reconciling the crack growing and failing the pressure vessel with what we know about pressurized thermal shock. It seems like they have an awfully high probability of failing that vessel just by the crack growing.

VICE CHAIRMAN SHACK: It's a crack in a, you know, a three-eighths, sixteenth inch stainless steel skin.

MEMBER SIEBER: With 2,000 pounds --

CHAIRMAN WALLIS: Which is already there, there's a crack there.

MEMBER SIEBER: Right.

MR. CHOKSHI: It's in the cladding, yes.

MR. DeMOSS: Yes, we've lost the wall.

MEMBER KRESS: So the growth rate from that --

MR. DeMOSS: Well, once he gets that crack, you know, it's a question then of whether it rips to give you, you know, how big will it rip?

MEMBER SIEBER: How big is the rip?

MR. DeMOSS: I think a crack is actually good news here. That gives you the chance of a small LOCA. If you wait until the things corrodes around the back and the thing goes pop, then you've got the large LOCA.

MR. CHOKSHI: If you look at it sort of from the metallurgical delimiter as you go forward, and then it's the rates of the head corrosion becomes pretty significant and the LOCA distribution is changing.

MEMBER KRESS: Well, in answer to your question about whether you can skip the grid, it's been the ACRS -- there's very high interest in the grid reliability. And I would vote against.

MR. DeMOSS: Well, I can run through quickly with an overview. The grid, from an ASP standpoint, the plants behaved as expected. And no major equipment problems, as you know. So the analysis of the grid LOOP were important but relatively uneventful from an ASP standpoint.

The important thing is the reliability of the grid which I don't have any additional information to add for you.

MEMBER SIEBER: Okay. Well, that was pretty quick.

(Laughter.)

CHAIRMAN WALLIS: Did they all have diesels or something that started?

MR. DeMOSS: All diesels worked just fine. And so ASP looked at probabilities of diesels not working coupled with other things necessary to get to core damage.

MEMBER SIEBER: Okay. So we covered this. You can move to Slide 19 now.

MR. DeMOSS: Okay. With that, Pat O'Reilly will take over.

MR. O'REILLY: All right.

VICE CHAIRMAN SHACK: But what's your conditional failure probability with eight plants undergoing this trend? I mean you presumably have that number, right?

MR. DeMOSS: The conditional probability for the eight plants, the final answers are from 40 to the minus six to three times ten to the minus five.

MEMBER SIEBER: Per plant.

MR. DeMOSS: Per each plant.

MEMBER SIEBER: Right.

MR. DeMOSS: And so they average about one times ten to the minus five.

MEMBER SIEBER: Yes, multiplied by --

MR. DeMOSS: If you care to multiply by eight, which we don't have any guidance to do.

CHAIRMAN WALLIS: But it's just like ten. It's another factor.

MR. DeMOSS: Right.

CHAIRMAN WALLIS: Like e to the minus.

MR. DeMOSS: Right.

MEMBER SIEBER: Okay. Slide 19.

MR. O'REILLY: Okay. I'm here to give you a brief overview of the SPAR Model Development Program. The purpose of the program is to develop PRA-based models which are used by staff analysts in performing their risk-informed regulatory activities.

And to date the SPAR Model Development Program consists of the following areas. We have model development work going on in Level 1 in internal events, modeling full-power operation in internal events, modeling all-power shutdown operation in internal events, excuse me, and in Level 1, modeling external events which include fires, floods, and seismic events, and so forth.

In the Level 2 area, to date we have developed models in the Large Early Release Frequency, or LERF category. Those models are deliberately designed to be expanded at some later date to consider full Level 2.

MEMBER ROSEN: On that slide --

MR. O'REILLY: Yes?

MEMBER ROSEN: -- No. 19 --

MR. O'REILLY: Yes?

MEMBER ROSEN: -- you say you are working on Level 1 external events? Are you including fire? Are you re-quantifying the fire models along the lines of the risk re-quantification work that's been done as a joint project between EPRI and NRES? Do you understand the question?

MR. O'REILLY: I understand the question.

The person is here -- I mean is not here that could answer it with certainty.

But what we're doing in that particular area is we're working in tandem with NRR and as NRR is going around visiting plants to gather information for their shutdown -- excuse me -- SDP process external events phase, we're collecting information from the licensee about their external events models, their PRAs. And we're using that information.

Now if that same information is the basis of --

MEMBER ROSEN: What's going to happen now, all plants have different fire models in their relatively immature technology. The current SPAR models have something in them for fire I assume as well. Is that correct?

MR. O'REILLY: Only two.

MEMBER ROSEN: Only two of all the models you have have fire?

MR. O'REILLY: Right. We consider fires to be an external event.

MEMBER ROSEN: Right.

MR. O'REILLY: Right. So the Revision 3 SPAR models do not have fire in them.

MEMBER ROSEN: Oh, okay. So plants that

have fire modeling have higher CDFs because they've taken whatever the contribution is from fire and included it and then you have.

MR. O'REILLY: Yes.

MEMBER ROSEN: Okay. Well --

MR. O'REILLY: At the present time, we're trying to --

MEMBER ROSEN: You're about to get passed by again. As the risk models are re-quantified on the basis of the new work by the plants, which will happen, not immediately but over time, then the Agency needs to follow along and not get too far behind.

MR. CHEOK: I think I'd like to respond to that. I don't think we're being passed by again. I think we're trying to keep up. And I think we will -- it's in our plans to incorporate external events, LOCA, and shutdown models within the next two years.

MEMBER ROSEN: Okay. Do keep up.

MR. O'REILLY: As long as the budget --

MEMBER ROSEN: We don't want to end up back where we were before with the plants saying it's not credible because they don't have external events.

MR. O'REILLY: Right. And we don't want to be in that position either.

MEMBER ROSEN: Okay.

MR. O'REILLY: Okay. Next slide. In the area of internal events full power, we have the Level 1 Revision 3 SPAR models. And they consist of 72 plant-specific event tree-fault tree linked models that are used by the staff analysts in their activities such as the significance determination process.

They're used in Phase 3 analyses in the SDP. They're used by the analysts in the Accident Sequence Precursor Program. And they're also used in generic safety issue resolution. And they're used in other activities as well.

VICE CHAIRMAN SHACK: Now what's a III model?

MR. O'REILLY: The III, in that, Dr. Shack, the Is stood for Interim -- that meant that that particular model had not received an onsite review against the licensee's PRA. We no longer have any III models that are being used. They're all Revision 3. The set of Revision 3 models was completed in August of 2003.

Some recent accomplishments, well, one of the discussions that has gone on here several times has been the comparison of the SPAR models with the licensee's PRAs. We have, as we said, we've reviewed every one of the 72 Revision 3 models against the respective licensee's PRAs.

We also conducted a pilot program within the context of the Mitigating System Performance Index Development Program in which we did a cut set level review of the specific SPAR model against the licensee's PRA. And we identified the differences between the licensee's PRA and the SPAR model. And we ended up -- there's a presentation we gave at the NSRC last fall on the results of that specific review.

We've also gotten feedback from a lot of our users, both the ASP analysts and the regional office SRAs that are using the SPAR models in Phase 3 analyses in the SDP.

As a result of all of this information, we have identified a number of modeling issues which are contributing to the differences between the licensee's PRA results and the results obtained with the specific SPAR model. We have prioritized these issues in the order in which they impact that difference between the two sets of results.

We have put together a program for addressing the key significant issues that are driving those differences. And we are embarking upon an effort which most of them entail engaging the industry at one level or another, be it industry-wide, be it owner's groups, or some specific portion of the industry, to try and reach agreement on these issues.

The agreement then would be factored back into the specific SPAR models that are appropriate.

Yes?

MEMBER DENNING: Yes, I'd like to know what you do with regards to uncertainty in modeling. The thing that concerns me about what you're are doing is I think that it is important that we do the comparison with industry and see where the difference is. And where it is clear that there is a preferred method or values, to use those.

But I'm concerned that we artificially drive a uniformity. We have a process in which the industry models look just like the NRC models. And they both have uncertainties that are being washed under the rug.

And so the question is we not only have to know that SPAR agrees with industry -- and that in itself is not essential. I think the essential thing is to know for our analyses of the SPAR model, how uncertain are they.

MR. O'REILLY: We handle uncertainty in the SPAR models in two ways. The first is parameter uncertainty. We have the capability and we are doing it now in the ASP analyses that we produce, to propagate the uncertainty in the equipment failure probability input value to the SPAR models as well as the capability to propagate the uncertainty in the human error probabilities that are used in the SPAR models.

In the issue of model uncertainty, that becomes a little more problematic as you well know. And in that particular case right now, we are addressing that by performing sensitivity studies in individual cases to see if we can get a handle on the model uncertainty.

MEMBER DENNING: So in a typical application, are you indeed running those uncertainty analyses? Because all I tend to see are single-valued results and I don't see the uncertainty bands on the results when I see what we use -- what we see when we're looking at risk informing and this kind of stuff.

In an application, do you run this uncertainty?

MR. O'REILLY: We do that within the context of the ASP Program, yes. I cannot speak for the rest of the uses of the SPAR models right now.

I'd have to go check with all the users.

MEMBER ROSEN: Well, I saw error bands on some of your charts. But typically if you're reporting a number, say one e to the minus five for some conditional core damage probability, would you report that with a plus or minus, you know, along with it?

MR. O'REILLY: Yes, we would in the ASP Program, that's correct.

MR. CHEOK: In all our recent ASP analysis, we report a mean value with uncertainty bands so that's included.

MEMBER ROSEN: E value and what?

MR. CHOKSHI: Plus the uncertainty.

MEMBER ROSEN: I think on that other chart that we saw, though, we saw sensitivity studies as opposed to the uncertainty bins.

CHAIRMAN WALLIS: Yes. Plus or minus would be dangerous because you might get negative values because it's probably a low arrhythmic thing.

VICE CHAIRMAN SHACK: On the MSPI, you know, we hear that the industry, in some cases, has quality problems. Are these model quality that you're getting different answers than they are for the MSPI or are they QA problems that the documentation isn't right?

MR. O'REILLY: Well, I don't have a lot of time to go into the detail on how we did the review during the MSPI Program but what we did do was a series of calculations where we compared the SPAR model as was against the licensee's PRA as it was, as we were given the information at the cut set level.

We then looked at the differences. We discussed with the licensee where the differences were to see if we could get some idea of what was causing the differences. Most of the time, it was due to differences in input data, either for the equipment failure probabilities or the human error probabilities or both. And sometimes it was due to the treatment of common cause failure probability.

What we did then was we went and took -- make a change set using all of the licensee's data input, ran that with the SPAR model. And most of the time after we had determined that the response of the plant had been modeled correctly, that's what we wanted, we found that we had an absolute overlay with the licensee's results.

Now, given that, we then went back and determined how many of those input value assumptions we could accept. Some of them were not consistent with our licensing policy.

Because if we were to accept a specific assumption within the context of the SPAR Model Development Program, that would give the impression that the Agency had approved that assumption. And in some cases, we just could not do that.

So we essentially agreed to disagree in those case. And that specific difference cause became a modeling issue. So the answer to your question is it is a mix. It really is.

But a lot of the differences that still remain are due to modeling issues although from what we have seen -- we just did a data update, which I'll refer to in a few minutes, which has made a very stark change in our basic results that may have taken away some of those big issues.

MEMBER ROSEN: Modeling issue?

MR. O'REILLY: Yes.

MEMBER ROSEN: The stark change was that the modeling issue delta --

MR. O'REILLY: Yes.

MEMBER ROSEN: -- if I can call it that, has narrowed?

MR. O'REILLY: Yes.

MEMBER ROSEN: Okay. Well, I expect that.

MR. O'REILLY: Yes.

MEMBER ROSEN: I mean unexpected -- and the reason would be that you have better data of what is in the plants. And what they're modeling.

MR. O'REILLY: Right.

MEMBER ROSEN: And they've been able to justify that to you.

MR. O'REILLY: Right. Now right now we're using industry average values because on a plant-specific basis, there are a number of plants for which there just isn't enough data to have much confidence in.

MEMBER ROSEN: For failure rates, sure. But I'm just talking about the one plant in 100 or 50 that happens to have a LOCA seal -- or RCP pump seal injection system.

MR. O'REILLY: Okay.

MEMBER ROSEN: And you didn't have that in your SPAR model, let's say.

MR. O'REILLY: Originally. Until we went to the site.

MEMBER ROSEN: And then found out yes, indeed, the plant has this seal injection system on the RCP. See, we didn't know that.

MR. O'REILLY: Right.

MEMBER ROSEN: Well, if you read the FSAR, you would have know it but when you can go out in the plant and kick the pump, but it's there so you model it. So that's the difference.

MR. O'REILLY: That's correct.

MEMBER ROSEN: I mean those kinds of things are just a question of maturation of the data interchange.

MR. O'REILLY: Yes. Once we got the modeling -- the fidelity of the model to the plant's response, then it zeroed in on other issues now. And that's where we are.

MEMBER BONACA: On failure data, what -- you start with a generic database and then you look at the significant differences? I mean the licensees, many of them use plant specific.

MR. O'REILLY: That's correct. And what we use in the model, the default values are industry averages. But if you were performing an ASP analysis of a condition or an event that occurred or was discovered at a specific plant, then if the data became an issue and the licensee had better data and it was well supported technically, then we would use that.

MEMBER BONACA: Okay.

MR. O'REILLY: That did not mean that we would go back and use the default values in the SPAR model. Don't get me wrong yet.

MEMBER BONACA: Okay.

MR. O'REILLY: We're still working on where to go with that. That would be the ideal situation if some day we could go there.

Okay. We also incorporated an improved loss of outside power and station blackout module. And we put in new reactor coolant pump seal LOCA models for PWR models in the case of Combustion Engineering and Westinghouse PWRs.

We updated the equipment failure data, the initiating event frequency data, and the common cause failure alpha factor data that are in the SPAR models with more recent data.

We completed a cut set level review of six models. That is in addition to the 11 plant models that we had already done within the context of the MSPI Program.

MEMBER ROSEN: Does that mean that you check the truncation levels?

MR. O'REILLY: Absolutely.

MEMBER ROSEN: Is that what that bullet is about?

MR. O'REILLY: Yes. We start out with a minimum of 5,000 cut sets. And go to that level of detail because we're trying to duplicate the MSPI. We want to make sure that if we are estimating the MSPI that we and the licensee are not going to have big --

MEMBER ROSEN: Dropping off different numbers of sequences.

MR. O'REILLY: Yes.

MEMBER ROSEN: Okay.

MR. O'REILLY: Future plans for the Revision 3 SPAR models, and I want to recognize Mr. Rosen's contribution in this because he jogged my memory. First of all, we're going to complete development of the set of enhanced Rev 3 SPAR models by April of 2007.

And that's a two prong project. First is to incorporate resolution of the significant key modeling issues that we've described. And that's a set of about ten issues.

There are probably 30 issues altogether but some of them don't have much of a significant impact on any models. But we've identified them as reasons for the differences between the SPAR models and the PRA results.

And we'll complete cut set level reviews for the rest of the 61 non-MSPI pilot program plants.

We also will prepare guidelines for using the SPAR models in events analysis which are consistent with the objectives of the Risk Assessment Standardization Project or RASP that you've heard about here.

And finally, we will establish a mechanism for updating the SPAR models accordingly as licensees update their plant PRAs. We thought we had something in process earlier in the MSPI Development Program whereby the industry had committed to provide us with periodic notices of updates of their PRAs. And that kind of fell through. So we're having to work another avenue or two.

And you mentioned it -- brought it to my mind. I wanted to bring that out. We will do that.

In the area of low power shutdown SPAR models, we currently have 11 low power shutdown SPAR models of which five have been through an onsite QA review process to review the SPAR models against the licensee's shutdown PRAs.

And we will continue to develop additional models and to review the models onsite against the respective licensee's PRA.

We'll issue the SPAR-H Methodology Report as a NUREG/CR. I believe we came to the Committee last year and gave a presentation on that. It's been through peer review. We had on the order of 100 comments.

And it's taken quite a while to get the comments sorted out, and addressed, and resolved appropriately. But sometime before the end of the fiscal year, we should get that report published and you will have a copy of it.

We also want to prepare guidelines for performing risk analyses using the low power shutdown SPAR models.

Events analysis capability, this is one that you probably haven't had too much information about up until now. The objective of this is to develop models that are capable of estimating the risk associated with external events initiators.

To date we have completed a feasibility study which showed the technical and economic feasibility of incorporating external events into the existing Revision 3 SPAR models by simply expanding them to include initiators that are external event related.

We've completed an effort to incorporate external events into the SPAR models for the Limerick

One and Two plant and the Salem Units One and Two plant.

Our future plans include developing external events models for all Rev 3 SPAR models and preparing guidelines for performing analyses using those models.

MEMBER ROSEN: I don't want to necessarily complicate this.

MR. O'REILLY: Sure.

MEMBER ROSEN: But just a thought for you to put in the back of your head is that someday you're going to have to incorporate external events in low power and shutdown models as well.

MR. O'REILLY: That one is one that is giving us grief right now as we speak. Yes.

MEMBER ROSEN: If you want to stay up, you're going to have to do that, too.

MR. O'REILLY: To put the LERF, it is not a problem. It's the low-power shutdown one that's --

MEMBER ROSEN: We could talk about it later maybe.

MR. O'REILLY: Okay. Because we're open to suggestions on that one.

MEMBER POWERS: Just a question. You implied the industry is moving aggressively to make their PRAs extremely comprehensive. And yet we can't seem to get them to do this parameter uncertainty analysis.

MEMBER ROSEN: Well, Dana, it's always a case of some are moving aggressively to make their PRAs comprehensive. And some can't spell PRA. It's just a mixed bag. But if the Agency wants to keep up, perhaps they could go to the places where they're moving comprehensively and see what's being done more aggressively.

MR. O'REILLY: That's where we've started.

MEMBER ROSEN: Yes.

MR. O'REILLY: Yes. In the area of LERF SPAR models, there again the objective is to develop analysis tools that allow us to perform risk assessments involving LERF or Level 2 considerations.

We've completed the LERF SPAR models for two lead plants. One is the Westinghouse PWR with large dry containment. There the lead plant was Comanche Peak.

And a SPAR model for BWR three or four with a Mark One containment. There the lead plant was Peach Bottom.

We're currently working on a third LERF SPAR model for a Westinghouse PWR with an ice condenser containment and Sequoyah is the lead plant for that.

And that concludes the SPAR model part of the presentation.

MEMBER KRESS: I presume these SPAR models are containment, early failures.

MR. O'REILLY: Yes.

MEMBER KRESS: And don't include fission products.

MR. O'REILLY: Oh, no. Not yet. That's correct.

MEMBER KRESS: Well, do you have any plans for doing a complete Level 2 that includes light containment failure or all containment failure types along with fission products?

MR. O'REILLY: As I mentioned I think when I first started the presentation, the LERF SPAR models are deliberately designed to be expanded at a later date --

MEMBER KRESS: Yes.

MR. O'REILLY: -- if the need comes to have to model full Level 2 later releases. So the answer is yes.

MEMBER KRESS: Well, you know, if you're just looking at the plant fatality safety goal, the

LERF that you're doing is adequate. But I don't think that's a complete picture.

MR. O'REILLY: Nor do we.

MEMBER KRESS: So I would like to see you think along the lines of a complete Level 2 at some point.

MR. O'REILLY: Right. We attempted to get that into the users need the first time around and it didn't make it.

MEMBER KRESS: Right. Okay.

MR. O'REILLY: But we're ready and willing to go that next step.

MEMBER KRESS: Would it be any help if the ACRS wrote a letter?

MR. O'REILLY: It wouldn't hurt.

(Laughter.)

MEMBER APOSTOLAKIS: An ACRS letter that would not hurt.

(Laughter.)

MEMBER SIEBER: Okay, I think we're ready --

MR. CHEOK: Okay, I'd like to wrap up our discussions --

MEMBER SIEBER: -- ready for the summary.

MR. CHEOK: Okay -- by just providing a

quick summary of the ASP and SPAR Programs and by highlighting some upcoming activities.

I guess first of all, I'd like to say that the ASP Program continues to be an important Agency program used to evaluate significant operating events.

For example, the analysis of the event at Wolf Creek and the analysis of the 2003 loss of outside power events in the northeast U.S. provide valuable and timely insights to guide further NRC actions.

The ASP analyses have been used to support AIT at plant sites. The most recent example is the 2003 loss of outside power event at Palo Verde for all three units last June.

The ASP insights have also been used to identify potential generic issue. For example, there in D.C. Cook, we raised about 100 issues, the most significant ones being the equipment qualification issues, high energy line break issues, and the sump issues.

So the ASP Program has evaluated approximately 700 precursors. We maintain the information on these precursors in our database.

This data is used in programs such as the Regulatory Effectiveness Program. For example, NUREG-

1784, published in 2003, provided insights into the potential risk from grid events prior to the August 2003 events.

The next bullet basically says that we provide results of the ASP Program to the Commissioners in an annual SECY paper and to the Congress in an annual Performance and Accountability Report. This provides a historical documentation of the events and provides measures of industry performance. Both of these reports are available to our stakeholders.

I guess last, as Dr. Apostolakis said earlier, we do a good job performing ASP analysis but we really do not do that good of a job using the results and insights from these analyses. We are currently initiating a task to do just this.

MEMBER APOSTOLAKIS: Well, yes, I mean I wouldn't use the words you're not doing a good job. I mean I think --

MR. CHEOK: Well, we can do a better job.

MEMBER APOSTOLAKIS: -- we all need to find a way --

MR. CHEOK: We can do a better job.

MEMBER APOSTOLAKIS: -- to disseminate information. I mean I would never think of criticizing your job.

MR. CHEOK: Thank you.

MEMBER ROSEN: Well I think from listening to this, you have come a world ahead of where you were years ago.

MEMBER APOSTOLAKIS: It's one of the best groups at the NRC.

MEMBER ROSEN: So I think, you know, you should not be too bashful.

MEMBER APOSTOLAKIS: Well, Mike can't help it. But the other guys --

(Laughter.)

MR. CHEOK: So where do we go from here. I think --

MEMBER APOSTOLAKIS: You remember him from 1174, right?

MR. CHEOK: Yes, I was.

MEMBER SIEBER: Right.

MEMBER APOSTOLAKIS: An old horse.

MR. CHEOK: So where do we go from here? I guess first and foremost, we need to improve on the timeliness of ASP analysis. Dr. Wallis, among others, have pointed out when they've seen our ASP trend charts that the data only goes up to 2002.

We, I guess, for various reasons, for

example the modeling of complex issues like Davis-Besse, the including of new methods like uncertainty methods, we have fallen behind a little bit on our analysis. Our goal is to get back to providing you with an analysis within four to 12 months of the event happening.

We have a program in place for this catch up and it is working. For example, for the Palo Verde LOOP event in last June, we finished our analysis in three weeks. And that analysis was used to support AIT at the site.

The current status calls for us to finish FY '04 events by the fall of this year. So essentially we should be up to date by the end of this year.

The second bullet basically says that using RASP initiatives, we'd like to interact more with the other programs in the Agency, the SDP programs and the MDA.3 programs. We believe that we will achieve a lot better efficiencies performing analysis in this way. However, the ASP Program will continue to concentrate on potentially significant events, those unique events, and those events that may have generic importance so we continue to learn from these events.

Finally, as we have said several times before, we will continue to look at the events in our ASP database to see if there are additional trends, insights, or lessons learned that would be useful for our Agency's processes.

Pat had mentioned many users of the SPAR Program and the SDP Program, the ASP Program, GSI Resolution. We use them to support reviews of our risk-informed license amendments and we also use them to support MSPI implementation.

Just recently there has been some talk, and Mr. Rosen raised this, of using licensee PRA models in place of SPAR models. Although there are some advantages of using the licensee models, we believe there are a lot of many advantages of using SPAR models.

First, the use of standardized models will reduce the variability in the results. By this we mean that when we have differing results from different plant models, we can be confident that these differences are from plant-specific design or operational differences and not from differences in the use of HRA methods or seal LOCA models or different assumptions.

So this feature is actually quite

important for the work we do, especially in things like GSI resolution, ASP and SDP analysis, and other applications.

Secondly, I think the use of a single software package and common PRA model is efficient. When different analysts have to learn three or four different licensee packages and when they have to learn to use the different nomenclature in these packages, not to mention the different event tree-fault tree methods, for example Risk Man versus Capital, this could lead to potential analyst errors. The use of a single common software in models will tend to eliminate these kinds of errors.

And finally, as Mr. Sieber had said at the beginning, the use of SPAR models will provide an independent verification of the licensee risk evaluations and findings.

MEMBER BONACA: Well, I would a couple of additional considerations. One is that it seems to me that at some point, you will beyond the capabilities of some of the licensees in that you'll have models like shutdown of the power that they don't have.

And the other benefit that I see is that use of a single model allows you to begin to make comparisons among different results for different plants which right now is very difficult to do.

MEMBER ROSEN: I suggested stopping the SPAR model development years ago when the models were not credible and you didn't have the kind of expertise and effort that you've got going now. I no longer support that earlier view that I had. I think this is a better solution for the Agency what you're doing now.

MR. CHEOK: Thank you.

MEMBER SIEBER: Well, if you do make a mistake, it's consistent.

(Laughter.)

MR. CHEOK: That's true.

MEMBER ROSEN: It's still, you know, important and valid to go to the plants and check what you're getting out of your SPAR model because you might still learn something. But then again, so might the plant. And that's a good thing, too.

MR. CHEOK: We totally agree with that. I think we learn things when we go to the plant. And the licensees learn things when we come to the plant.

A recent example is when the licensees update their models when we show them what we have in the SPAR models so it is mutually beneficial.

MEMBER ROSEN: It's a two-way street.

It's the best of all possible worlds. It's a win-win situation.

MR. CHEOK: So what are the steps forward for the SPAR Program, as Pat said, we would like to complete all Revision 3 enhancement by next year. We would like to increase the scope of our analysis so that we can provide tools to enhance Agency risk-informed decision-making. This is consistent with the Reg Guide 1.174 philosophy.

We would like to enhance user friendliness of our models and software. We will continue to interact with our analysts in the regions and in NRR for the SPAR model users group to get feedback as to where these improvements need to be. And we will continue to train our regional NRR analysts in the use of SPAR models.

Finally, over the next few years, we would like to perform a peer review of the SPAR models against industry PRA standards. As with all PRA quality initiatives, we will have to keep the intended users of the SPAR models in mind during this peer review process.

MEMBER ROSEN: And when you do the peer review process, you are going to get facts and observations and correct the SPAR models I presume?

You'll go the whole way?

MR. CHEOK: We will get lessons learned as to how we can improve the models, that's correct.

MEMBER ROSEN: You won't just do it as an exercise. You'll do it to do just what the utilities are doing. Go through the certification. Get the facts and observations. Categorize them. And go and improve the models.

MR. CHEOK: I'm not sure. This process has not been clear yet.

MEMBER ROSEN: Well, I would recommend --

MR. CHEOK: I'm not sure what the process will do but we will do a similar process.

MEMBER ROSEN: I would recommend that you not enter this as an exercise in an academic -- you need to enter it as an exercise in improvement.

CHAIRMAN WALLIS: What was the word academic used for in that context?

(Laughter.)

MEMBER APOSTOLAKIS: Exercises in academia are taken very seriously.

MEMBER ROSEN: Which has to do with not doing anything with the result except publishing and putting on the shelf.

MR. O'REILLY: Oh, no. We --

MEMBER ROSEN: You need to fix the models if you find things wrong with them.

MR. O'REILLY: -- that's what -- actually we've had this performed once already. And we got a lot of good information out of that. And we have improved that particular SPAR model as a result of that review.

MEMBER ROSEN: The process inherently uses peer review which means that you might even use some people from the industry to help you.

MR. O'REILLY: That's exactly what we did.

CHAIRMAN WALLIS: As long as they're up to academic standards.

MEMBER ROSEN: As long as they're academically superior. And non-academic in terms of the use of it.

MR. O'REILLY: Well, they had been the team leader on a couple of the peer reviews from the industry, yes.

MEMBER SIEBER: I presume that concludes your presentation?

MEMBER DENNING: Now, we --

MEMBER SIEBER: Go ahead, I'm sorry.

MEMBER DENNING: Well, right now we did not have a plan to write a letter.

MEMBER SIEBER: That's right.

MEMBER DENNING: But we could decide to do that, I guess, if we discuss that later.

MEMBER SIEBER: We could.

MEMBER DENNING: Will they come -- what's the periodicity with which we hear this program? I certainly thought it would be --

MEMBER SIEBER: Just about every year.

MEMBER DENNING: -- annual at least.

MEMBER SIEBER: It's about every year.

MEMBER DENNING: Yes, okay.

MEMBER SIEBER: We had a similar presentation last year.

MEMBER APOSTOLAKIS: We have a subcommittee -- as you know, we are reviewing the research quality of various activities. And one of them is SPAR. And there is a subcommittee that -- oh, you are fully aware of it.

PARTICIPANT: Oh, definitely, yes.

MEMBER APOSTOLAKIS: We probably need a subcommittee meeting. So sometime in the June, early July frame, the subcommittee is Mario Bonaca, Rich Denning, and me.

Others are welcome to come, of course, but the three of us will probably be there for sure. So don't be surprised if we do that.

MEMBER ROSEN: Dana, as an aside, are we moving ahead with those efforts? Where do we stand?

MEMBER POWERS: Well, George has everything he needs, I think, right?

MEMBER APOSTOLAKIS: I got a big binder. I'm going --

MEMBER POWERS: I have now the materials for the thermalhydraulics for Mr. Wallis.

I have for the Steam Generator for Mr. Sieber.

MEMBER SIEBER: Yes.

MEMBER POWERS: The containment capacity for Dr. Shack.

And I think we'll probably discuss those at P&P?

MEMBER APOSTOLAKIS: Very good.

MEMBER SIEBER: Okay. Any further questions from Members?

(No response.)

MEMBER SIEBER: I'm impressed with the presentation. And I'm glad that you made an effort to make the presentation schedule with us. And we'll be interested in keeping track of your progress. And with that, Mr. Chairman, I'll turn the meeting back to you.

CHAIRMAN WALLIS: Thank you very much. Thank you for your presentation.

We will now take a break, 15 minutes. And I don't think we need the Reporter any more. Thank you very much -- the transcript. We'll take a break until five minutes before eleven.

(Whereupon, the above-entitled meeting was concluded at 10:42 a.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 521ST Meeting

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.

Eric Hendrixson
Official Reporter
Neal R. Gross & Co., Inc.

BRIEFING OF THE ACRS ON THE ACCIDENT SEQUENCE PRECURSOR (ASP) AND SPAR MODEL DEVELOPMENT PROGRAMS

April 8, 2005

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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Outline of Presentation

- Introduction & Background (N. Chokshi)
- ASP Trends & Insights (G. DeMoss)
- Davis-Besse ASP Analysis (G. DeMoss)
- ASP Analysis of the August 14, 2003 Grid Disturbance in the Northeast United States (G. DeMoss)
- SPAR Model Development Program (P. O'Reilly)
- Summary (M. Cheok)

Purpose of Briefing

- To provide an update of the ASP program and to discuss some of the ASP trends
- To discuss the ASP analyses of two events of interest
- To provide the status of the SPAR Model Development Program
- To briefly discuss the Risk Assessment Standardization Project (RASP)

ASP Program Background

ASP has been a part of NRC events analysis activities for about 25 years, and it has a variety of internal and external users.

- The primary objective of the ASP Program is to systematically evaluate operating experience to identify and document events likely to lead to core damage. Analyses are performed to define and project potential accident scenarios, determine risk exposure, and assess risk mitigation measures.
- ASP analyses are also used to support:
  - Performance measures in the Annual Performance and Accountability Report to Congress
  - Industry trends program
  - Decisions to develop generic communications
  - Studies to determine the safety significance of potential regulatory issues
  - A partial check on PRA scenarios

Differences between ASP and SDP Processes

- ***Applicability*** — ASP considers all events, including concurrent multiple degraded conditions; SDP considers degraded conditions with licensee performance issues
- ***Information*** — ASP benefits from information sources with longer lead time (root cause analysis, research, and expert elicitation); SDP constrained to short schedule to issue final significant determinations
- ***Models*** — ASP uses SPAR models and SPAR models modified for unique condition-specific considerations; SDP uses plant-specific notebooks for Phase 2 and assortment of models for Phase 3 (SPAR models, licensee's PRA, modified notebook)
- ***Uncertainty*** — ASP estimates parameter uncertainty through SPAR models and modeling uncertainty through sensitivity analysis; SDP Phase 2 notebooks designed for higher level of tolerance for overestimating risk and SDP Phase 3 may use sensitivity analysis

ASP RESULTS, TRENDS & INSIGHTS

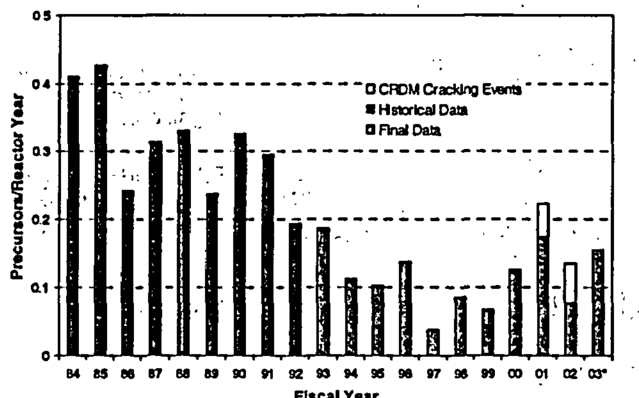
Summarized from SECY-04-210

- No *significant* precursors were identified in either FY 2003 or FY 2004. Davis-Besse was a significant precursor in FY 2002
- Ten precursors identified in FYs 2001–2004 had a CCDP greater than 1×10^{-4}.
- No trend was identified in the rates of occurrence of all precursors during the period from FY 1993 through FY 2002.
- Trending of precursors by CCDP bins yielded mixed results. If a trend is considered statistically significant, it is very unlikely that the trend is a result of chance alone. Trending analysis of precursors in the CCDP bins yielded the following results:
  - CCDP > 1×10^{-3} — No trend
  - 1×10^{-3} > CCDP > 1×10^{-4} — Decreasing trend - almost statistically significant
  - 1×10^{-4} > CCDP > 1×10^{-5} — Decreasing trend - statistically significant
  - 1×10^{-5} > CCDP > 1×10^{-6} — Increasing trend - statistically significant

ASP RESULTS, TRENDS & INSIGHTS

No trend was identified in the rates of occurrence of all precursors during the period from FY 1993 through FY 2002

Number of Precursors by Fiscal Year

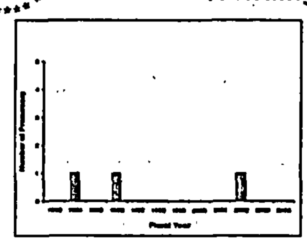


*Contains preliminary data

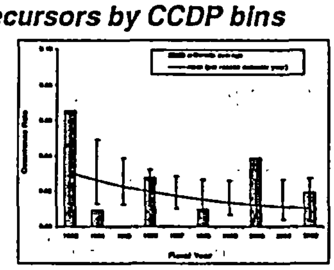
Source: SECY-04-210

ASP RESULTS, TRENDS & INSIGHTS

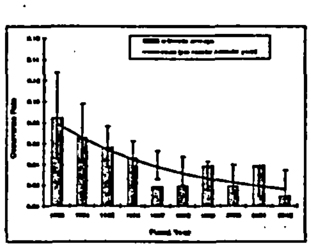
Trending of precursors by CCDP bins



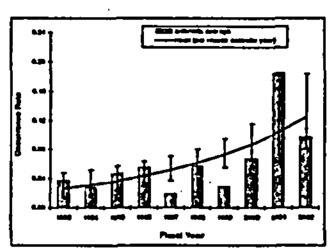
Precursors in CCDP bin 10^{-3}



Precursors in CCDP bin 10^{-4}



Precursors in CCDP bin 10^{-5}



Precursors in CCDP bin 10^{-6}

Source: SECY-04-210

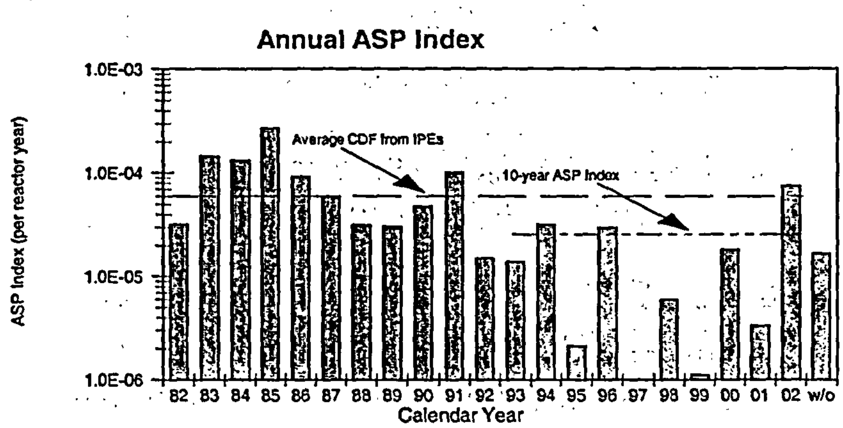
ASP RESULTS, TRENDS & INSIGHTS

Detailed study into trends to be performed in FY 2005/2006

- Trends to be investigated include:
  - Precursors involving initiating events are decreasing.
  - Precursors involving conditional unavailability of equipment may be increasing.
  - Precursors involving loss of offsite power are increasing.
  - No apparent trend related to plant type (BWR vs. PWR).
  - Trend of all precursors is very low for some years.
  - Causes of precursors to be investigated.
- Investigation will include contributions from:
  - Introduction of the Significance Determination Process in April 2000.
  - Revision of the SPAR models (Rev 3 in 2001).
  - Changing licensee performance.
  - Plant aging.
  - Industry/NRC initiatives (e.g., maintenance rule).
  - Outliers in plant performance.
  - Changes in ASP screening criteria and analysis methodology.

ASP INDEX

(The total CCDP of all precursors divided by the total number of Rx years)



Source: SECY-04-210

ASP RESULTS, TRENDS & INSIGHTS
Summary of Observations

- We observed:
  - One potentially significant precursor in 2002 (Davis-Besse).
  - No indication of an increase in the severity of precursors.
  - No significant trend in the number of precursors over the last 10 years.

- Several significant ASP analyses are highlighted for the rest of this presentation.
  - Davis-Besse required a unique analytic approach to quantify this significant precursor.
  - ASP results and insights were used in the Agency's action plan for resolving electrical grid concerns.

Analysis of Conditions at Davis-Besse
This analytic approach yields a realistic, integrated risk analysis of three conditions at Davis-Besse

- Latent debris in containment caused by unqualified coatings, uncontrolled fibrous material and other debris that could clog the emergency sump following a loss-of-coolant accident
  - Sump failure probabilities (based on GSI-191 research) are the subject of ongoing industry and NRC work

- A design deficiency in the high-pressure injection (HPI) pumps that could cause pump failure during the recirculation mode of emergency core cooling
  - Testing and analysis proved that HPR would fail if there was any fiber in the sump water, thus failure was assumed for all LOCAs

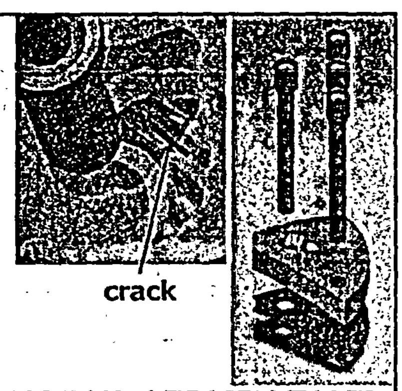
- CRDM nozzle cracking and leakage that led to cavity formation and could have resulted in a LOCA
  - Used expert elicitation to determine distribution of possible conditions of the head in February 2001 and degradation rates
  - Used Monte Carlo analysis of alternative scenarios to determine failure mode (SLOCA, MLOCA or LLOCA) probabilities
  - Used analytic tool developed by RES to estimate probability of MLOCA from CRDM ejection

An Assessment of the Structural Integrity Challenge Posed by Boric Acid Wastage in the Davis Besse RPV Head

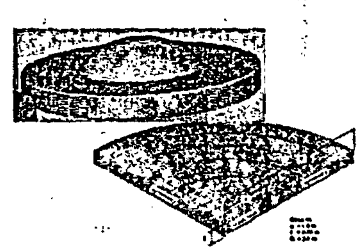
Objectives

- Assess the structural integrity of the primary reactor coolant pressure boundary for the conditions that existed at Davis Besse on February 16, 2002
- Assess the structural integrity of the primary reactor coolant pressure boundary for conditions postulated to exist at Davis Besse had it not been taken off-line for a scheduled maintenance outage on February 16, 2002
- Assess the structural integrity of the primary reactor coolant pressure boundary for conditions postulated to exist at Davis Besse for the year preceding February 16, 2002 +/- 1 year (ASP analysis)

Overall Methodology



- Detailed analysis of as-found state (geometrically accurate model) provides reality benchmark
  - Predicts non-failure of as-found (16th Feb 02) state
  - Failure modes calibrated using large scale tests
  - Simplified models used in forward- and backward-looking analyses corrected relative to as-found model



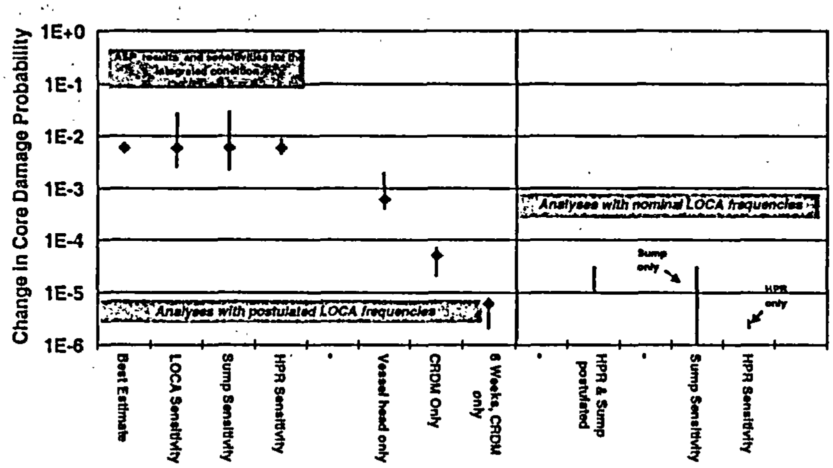
- Forward looking analysis
  - Uses simplified model
  - As-found state is certain
  - Results have been reported in letter to EDO
- ASP analysis: backward looking
  - Uses simplified model
  - As found state is uncertain
  - State 1 year prior to 16th Feb 02 estimated by expert judgment

Key Findings of the Structural Analysis

- No failure on day of discovery. Pressure in excess of relief valve setpoint pressure needed to fail. Factor of ~1.5 safety margin on pressure.
- For the as-found condition, median time of continued operation needed for failure is approximately 5 months (uncertainty associated with this estimate is large)
- From ASP analysis (uncertain as-found condition)
  - ~20% (+/-5%) total failure probability on day of discovery
  - Most likely failure is a small break LOCA

ASP *Results and Sensitivity Analyses*

Results of all ASP risk calculations



DAVIS-BESSE ASP RESULTS

The risk at Davis-Besse was significant, but NRC and the licensee have taken actions to correct the deficiencies.

- DB is a *Significant Precursor* - $\Delta CDP = 6 \times 10^{-3}$
  - ΔCDP greater than 10^{-3} was reported to Congress per the Annual Performance and Accountability Report criteria.
  - 11 ASP events are higher – All occurred in 1985 or before.
  - Two other *Significant Precursors* in the last 10 years – Wolf Creek Drain Down Event (1994) and Catawba LOOP (1996)
- DB had a significant loss of safety margin involving the simultaneous degradation of three important safety features:
  - RCS pressure boundary,
  - containment sump, and
  - high pressure injection system.
- Sensitivity analysis shows that the results are consistently in the high 10^{-3} or low 10^{-2} range.

ASP Analyses for the August 14, 2003 Grid Event

This analytic approach yields a consistent risk analysis of eight loss of off-site power events

- Nine plants lost offsite power due to an electrical disturbance on the grid.
  - Eight plants (Fermi, Fitzpatrick, Nine Mile Point 1 and 2, Perry, Ginna & Indian Point 2 and 3) were at power, tripped and lost off-site power.
  - Davis-Besse was in a cold shutdown and lost off-site power.
  - Oyster Creek tripped, but did not lose offsite power to the vital buses.
- All affected plants successfully coped with the loss of offsite power.
- Off-site power recovery times and non-recovery probabilities are based on potential bus restoration times, which is the time grid operators gave the plant permission to use off-site power. Grid reports were used to judge the potential reliability of power.

Results of the Final ASP Analyses

- No major equipment failures (i.e., EDGs, turbine driven pumps, batteries)
  - CCDPs range from 4×10^{-6} to 3×10^{-5}
  - LOOP durations between 1 and 6 hours
  - CCDPs are very sensitive to recovery times, and sensitive to battery capacity, alternate AC power sources, and EDG common-cause failure parameters.
- Final results are nearly an order of magnitude lower than the preliminary results due to incorporation of EDG recovery and updated unavailability data into the SPAR models

SPAR MODEL DEVELOPMENT PROGRAM
Purpose and Scope

- To develop PRA-based models that are used by staff analysts in performing their risk-informed regulatory activities.
- Spans the following areas:
  - Level 1: Internal events, full power operation
  - Level 1: Internal events, low power shutdown operation
  - Level 1: External events (fires, floods, seismic, etc.)
  - Level 2: Large Early Release Frequency (LERF)

LEVEL 1, REVISION 3 SPAR MODELS

- Consists of 72 plant-specific, event tree-fault tree linked risk models for use by staff analysts in activities such as: Significant Determination Process (SDP) Phase 3 analyses, the Accident Sequence Precursor (ASP) Program, and Generic Safety Issue (GSI) resolution.
- Revision 3 Models were completed in August 2003

LEVEL 1, REVISION 3 SPAR MODELS
Recent Accomplishments

- Identified modeling issues that contribute to differences observed between the results from Rev 3 SPAR models and those obtained with the licensee's PRAs. Model enhancements are prioritized according to the impact of the issues on the results.
- Incorporated improved loss of offsite power/station blackout module and seal LOCA models for PWR models.
- Updated equipment failure data, initiating event frequency data, and common cause failure alpha factor data.
- Completed cut set level review of 6 models.

LEVEL 1, REVISION 3 SPAR MODELS
Future Plans

- Complete development of set of enhanced Revision 3 SPAR models by April 2007:
  - Incorporate resolution of significant, key modeling issues, as appropriate.
  - Complete cut set level reviews for 61 plants that were not Pilot Plants in the MSPI Development Program.
- Prepare guidelines for use of SPAR models in events analysis consistent with the objectives of the Risk Assessment Standardization Project (RASP).

LOW POWER/SHUTDOWN SPAR MODELS

- Currently consists of LP/SD SPAR models for 11 plants, of which 5 have been through the onsite review process to review the SPAR models against the licensees' shutdown PRAs.
- Future plans include:
  - Develop models for additional plants and perform onsite reviews of the models. Number of models will depend on available resources and availability of licensee shutdown PRAs
  - Issue SPAR-H methodology report as NUREG/CR.
  - Prepare guidelines for performing risk analyses using the LP/SD SPAR models.

EXTERNAL EVENTS ANALYSIS CAPABILITY

- Objective is to develop models that are capable of estimating the risk associated with external events initiators.
- Completed study that showed technical and economic feasibility to incorporate external events into existing Level 1, Rev. 3 SPAR models.
- Completed effort to incorporate external events into SPAR models for Limerick 1 & 2 and Salem 1 & 2.
- Future plans include:
  - Develop external events models for all Revision 3 SPAR Models.
  - Prepare guidelines for performing risk analyses of events/conditions involving external events initiators for use by staff analysts.

LERF SPAR MODELS

- Program objective is to develop analysis tools for performing risk assessments of events/conditions involving Level 2/LERF considerations.
- Completed LERF SPAR models for first two lead plants:
  - Westinghouse PWR with large, dry containment (Comanche Peak).
  - BWR 3/4 with Mark I containment (Peach Bottom).
- Currently developing LERF SPAR model for third lead plant – Westinghouse PWR with ice condenser containment (Sequoyah).
- Future plans are to complete models for an additional 7 lead plants and to conduct onsite reviews of models against licensees' Level 2/LERF PRAs.

SUMMARY
Accident Sequence Precursor (ASP) Program

- The ASP Program continues to evaluate the safety significance of operating events at nuclear power plants and to provide insights to NRC's regulatory programs.
- Since its inception, the ASP program has evaluated and documented in excess of 600 precursors which are maintained in the NRC's ASP database.
- The staff informs the Commission of the results of the ASP program in an annual SECY paper.
- The Reactor Operating Experience Task Force includes ASP analysis as a necessary function for an effective OE program and noted that "the limited evaluation of the overall ASP results for feedback to other regulatory processes is a missed opportunity to identify lessons learned."

ASP Program – Path Forward

- Improve timeliness of ASP analyses
- Achieve real time interaction with the Significance Determination Process and other events assessment activities in RES, NRR and the Regions through processes such as RASP
- Continue to concentrate on potentially significant events
- Complete study of ASP trends and insights

SUMMARY
SPAR Model Development Program

- The SPAR Model Development Program continues to provide tools that are used in many Agency programs
  - Evaluate risk significance of inspection findings as part of the ROP
  - Evaluate risk associated with operating events as part of the ASP Program
  - Perform analyses in support of generic/safety issue resolution
  - Perform analyses in support of the staff's risk-informed review of license amendments
  - Independently verify performance indicators as part of MSPI.
- Some advantages of using SPAR Models
  - "Standardized" models reduce variability in results due to use of different models, inputs, and assumptions
  - Use of a single software package increases efficiency and reduces potential for analyst errors
  - Provides an independent verification of licensee risk evaluations and findings

SUMMARY
SPAR Program - Path Forward

- Complete Revision 3 enhancements by addressing the risk-important issues.
- Complete additional LP/SD, LERF, and external events models to increase the scope of risk assessments and thus to enhance Agency risk-informed decision making.
- Continue to enhance user-friendliness of software and models; continue interactions with Regional and NRR analysts through the SPAR Model Users Group (SMUG); and continue training of Regional and NRR analysts.
- Perform a peer review of models against consensus PRA Standards, keeping in mind the intended uses of the models.