

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
Reliability & Probabilistic Risk Assessment
Subcommittee

Docket Number: (not applicable)

Location: Rockville, Maryland

Date: Thursday, November 17, 2005

Work Order No.: NRC-741

PROCESS USING ADAMS
TEMPLATE: ACRS/ACNW-005

SISP - REVIEW COMPLETE

Pages 1-318

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

**ACRS OFFICE COPY
RETAIN FOR THE LIFE OF THE COMMITTEE**

TR04

ORIGINAL

DISCLAIMER

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

November 17, 2005

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on November 17, 2005, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

This transcript has not been reviewed, corrected and edited and it may contain inaccuracies.

1 UNITED STATES OF AMERICA
2 NUCLEAR REGULATORY COMMISSION

3 + + + + +

4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 + + + + +

6 RELIABILITY & PROBABILISTIC RISK ASSESSMENT

7 SUBCOMMITTEE MEETING

8 + + + + +

9 THURSDAY,

10 NOVEMBER 17, 2005

11 + + + + +

12
13 The meeting was convened in Room T-2B3 of
14 Two White Flint North, 11545 Rockville Pike,
15 Rockville, Maryland, at 8:30 a.m., Dr. George E.
16 Apostolakis, Subcommittee Chairman, presiding.

17 MEMBERS PRESENT:

18 GEORGE E. APOSTOLAKIS Chairman
19 MARIO V. BONACA ACRS Member
20 RICHARD S. DENNING ACRS Member
21 THOMAS S. KRESS ACRS Member

22 ACRS STAFF PRESENT:

23 ERIC A. THORNSBURY ACRS Staff, Designated
24 Federal Official
25

ACRS STAFF PRESENT (Continued):

ASHOK C. THADANI Deputy Executive
Director, ACRS/ACNW

NRC STAFF PRESENT:

CHARLES ADER RES/DRAA
PETER APPIGNANI RES/DRAA/OERAB
MICHAEL CHEOK RES/DRAA/OERAB
NILESH CHOKSHI RES/DRAA/OERAB
DON DUBE RES/DRAA/OERAB
ELI GOLDFEIZ RES/DRAA/OERAB
CHAD HUFFMAN RES/DRAA/OERAB
CHRIS HUNTER RES/DRAA/OERAB
STEVE LONG NRR/DRA
DON MARKSBERRY RES/DRAA/OERAB
JEFF MITMAN RES/DRAA/OERAB
LYNN MROWCA NRR/DRA/APOB
DAN O'NEAL RES/DRAA/PRAB
JAMES VAIL NRR/DRA/APOB

ALSO PRESENT:

ROBERT BUELL Idaho National Laboratory
STEVE EIDE Idaho National Laboratory
JOHN SCHROEDER Idaho National Laboratory

C O N T E N T SPAGE

Opening Remarks, George E. Apostolakis	4
SPAR Model Development Program, Niles Chokshi .	5
Level 1 Internal Events, Michael Cheok	9
SPAR Model Demonstration, Dr. Robert Buell . . .	46
Major Modeling Assumptions, Dr. Robert Buell .	135
PRA Quality Reviews, Donald A. Dube	255
Status of Modeling Uncertainty in SPAR,	
Dr. John Schroeder	301

P R O C E E D I N G S

(8:33 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Reliability and Probabilistic Risk Assessment.

I am George Apostolakis, Chairman of the subcommittee.

Members in attendance are Mario Bonaca, Rich Denning, and Tom Kress.

The purpose of this meeting is to discuss the standardized plant analysis risk model development program. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full committee.

Eric Thornsbury is the Designated Federal Official for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on November 1, 2005. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 It is requested that speakers first
2 identify themselves and speak with sufficient clarity
3 and volume so that they can be readily heard.

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

7 We will now proceed with the meeting, and
8 I call upon Mr. Nilesh Chokshi to begin the
9 presentations.

10 MR. CHOKSHI: Thank you.

11 And I would like to begin by thanking the
12 committee for reviewing our station blackout study as
13 a part of the SPAR model development program and
14 giving us feedback with respect to fire attributes
15 which are used by the committee in the evaluation.

16 I think in going forward not only on this
17 project, but in other SPAR model developments, this
18 experience will serve us well in looking at the fire
19 attributes and use them as a bench product against
20 theoretically to measure our progress and monitor, you
21 know, how we are meeting those fire attributes. I
22 think it will serve as a good check as we move
23 forward.

24 I also want to thank you for giving us
25 opportunity to discuss SPAR models development in

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 detail, I think, and this is really a good time for us
2 to do that as we are in the formative stages in
3 several areas of model development. I think as you
4 will go through the presentation, you will see that.

5 As you will see here, we're going to cover
6 the full spectrum of the SPAR model developments,
7 internal events, external events, LERF, low power
8 shutdown, and they are at varying stages. You know,
9 they are in varying stages in their degree of maturity
10 and in their sophistication.

11 I think as, again, the committee noted in
12 the quality report, the SPAR model development is
13 making use of the existing state of the art and is
14 very closely tied to the plant specific plant PRA
15 models. So one of the key factors in development of
16 models is the availability of the plant models and the
17 nature of these models.

18 So as a result, I think in each of these
19 areas there are different types of challenges, you
20 know, in terms of what technical approach to be used,
21 how to develop models where there are no plant
22 specific models available, and what do you do about
23 the performing QS, the approach used and internally
24 arranged was a bit different because of the
25 availability of models, the maturity of the practice

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 is much developed.

2 So I think we are looking forward to
3 getting feedback on some of these challenges and
4 thoughts, you know, as you move along the development
5 of these other areas.

6 What I would like to do is now introduce
7 the team which is going to be up here today and
8 tomorrow, and from the staff you'll have the principal
9 staff members who are project managers in each of the
10 technical areas.

11 I think, as you know, Dr. Pat O'Reilly for
12 many years led the staff team, you know, in this and
13 also the oral SPAR model development program.

14 Don Marksberry is here, and I think he has
15 taken over that responsibility.

16 We also have principals from the Idaho
17 National Laboratory and Brookhaven who will give
18 detailed presentations on some of the aspects, and I
19 think it's leading off at the level of internal
20 events. I think it's very important. You'll see a
21 lot of details and how that is being developed.

22 So from the staff we have Don Marksberry.
23 Selim Sancaktar is going to talk about external
24 events. Eli Goldfeiz is living the live model
25 development, and Jeff Mitman will join us, just simply

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the branch, and he's leading the low part in shutdown
2 effort.

3 And from Idaho, we have Dr. Buell and Dr.
4 Schroeder. Schroeder doesn't talk about the leaders
5 of the internal events.

6 And Dr. Lehner will be here tomorrow.

7 Mike Cheek is going to lead off the
8 presentation with all of you. We also have Don Dube,
9 and we would like to give you some perspective on
10 lessons learned from the use of SPAR models in the
11 MSPI activities, and I think Mike is going to discuss
12 that as sort of an area I don't what to agenda.

13 I think I'd like to before I have Mike
14 talk about the overview, I'd like to make one point.
15 I think to me it's very important. You know, people
16 you are going to hear from and today I introduced,
17 they are the project managers, and they are obviously
18 in each of the model development, but there are many
19 other contributors in terms of many activities, you
20 know, directly or indirectly.

21 And also as Mike is going to very shortly
22 -- this is a very integrated effort involving SPAR
23 model and input development, which you are not talking
24 today, and also the strong user application interface
25 and feedback mechanism.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 Everything I think we do in my branch,
2 offering expert evaluation is very closely tied to the
3 SPAR models. So you'll see that, and you will see
4 clearly when Mike shows what we do and how these thing
5 are. So it just follows you throughout.

6 And so it's integrated. So I think
7 hopefully when we go through these presentations, you
8 will see some of the perspectives clearly, and with
9 that, Mike.

10 MR. CHEOK: Good morning. We'll be
11 touching upon a lot of topics, as you see, and these
12 topics are, I guess, preagreed upon in our agenda.
13 The one new topic that Nilesh touched upon is the one
14 on the MSPI lessons learned.

15 The agency currently is implementing the
16 mitigating systems performance index. As part of this
17 implementation, we are doing a review of the
18 licensee's PRAs and comparing the results from those
19 PRAs to SPAR models, and as a result of this
20 comparison, we are coming up with a lot of good
21 insights and lessons learned, and we would like to
22 share this with this committee.

23 So if you would like, we would like to a
24 half an hour slot with Don Dube to discuss the MSPI
25 lessons learned.

1 CHAIRMAN APOSTOLAKIS: You say you are
2 comparing your results with those of licensees, PRAs.
3 I thought you are doing it routinely as part of the
4 SPAR development. So what is this comparison?

5 MR. CHEOK: We are doing that anyway, and
6 we will discuss some of our QA activities as part of
7 Idaho's discussions today. What we're doing in the
8 normal basis is going to the plants, looking at their
9 PRAs, and now looking at their cut sets and comparing
10 cut sets.

11 This is another level of detail. We're
12 looking at influence measures. The bow and bar
13 (phonetic) measures that are used in MSPI, and they
14 give us a different perspective as to what components
15 in the plant can become important.

16 And in theory if you compare the high
17 level cut sets, you would be looking at perhaps the
18 top 90 to 95 percent of your CDF for some initiating
19 events that will not contribute as much to your CDF,
20 but they could have components that could become
21 important, and they will show up in your
22 (unintelligible) importances (phonetic).

23 We do not see that many differences, but
24 the differences we do see are quite enlightening.

25 MR. DENNING: the answer to the question,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 George though is probably yes, right? We do want to
2 hear the MSPI.

3 CHAIRMAN APOSTOLAKIS: Especially from
4 Dube.

5 MR. CHEOK: All right. What are SPAR
6 models? SPAR models are small event trees, large
7 fault PRA models. They are plant specific in that
8 they model plant specific system configurations, and
9 to a certain extent they model small --

10 CHAIRMAN APOSTOLAKIS: What did you say?
11 You said model fault trees? Say it again.

12 MR. CHEOK: They are small event trees and
13 large fault trees. So they're similar to the cap
14 during a neutral models and not quite similar to the
15 risk MAN models. They are standardized in other
16 areas, and we will discuss the standardization later
17 on today with INL.

18 We used the SPAR-H methodology to estimate
19 human error probabilities, and we will discuss SPAR-H
20 in December, in a December subcommittee meeting.
21 Component failures and initiating event probabilities
22 and frequencies are based on national generic plant
23 experience data for older models.

24 We would like to point out that the
25 purpose of the SPAR model development program is to

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 provide the NRC staff with literally available and
2 easy to use PRA models for use in performing risk
3 informed regulatory activities, and that's basically
4 our sole objective of the program.

5 CHAIRMAN APOSTOLAKIS: So the idea was
6 that the complete PRAs are not easy to use; is that
7 the point?

8 MR. CHEOK: Well, we are not saying the
9 complete PRA is not easy to use, and I wouldn't even
10 imply that the SPAR models are not complete PRAs. I
11 would like to think that they are complete PRAs. They
12 are standardized and they have similar methodologies.
13 Thereby the staff can now, if you're familiar, one
14 SPAR model you can use it for all 72 plants. You do
15 not have to use different methodologies for each
16 different plant. You do not --

17 CHAIRMAN APOSTOLAKIS: What would be the
18 difference, say, between two PRAs that the SPAR model
19 would eliminate and standardized? Would one PRA be
20 produced by risk MAN so it has huge event trees and
21 small fault trees, and you do your SPAR model for that
22 plant or you switch the other way? Is that one of the
23 differences you are eliminating?

24 MR. CHEOK: That's one of the differences
25 we eliminate.

1 CHAIRMAN APOSTOLAKIS: Are there any
2 others?

3 MR. CHEOK: Well, the other differences
4 would be how people would classify the basic events,
5 the terminology, how you would enter the standard
6 methodologies as to how we would classify basic events
7 by the component name, the tag number, and failure
8 mode. Other different plants and utilities would have
9 different terminology that we would have to learn,
10 same with initiating events, human failure events.

11 The other things would be the
12 standardization, and we'll talk about this later on.
13 It would be the standard success criteria that we
14 would use. We would have you assume two out of two
15 PORVs, for example, for feed and bleed.

16 The licensees may use other models to
17 justify perhaps one out of two PORVs for feed and
18 bleed.

19 CHAIRMAN APOSTOLAKIS: But is there any
20 detail in the licensee's PRA that is not inspired?

21 MR. CHEOK: The licensee's PRAs would tend
22 to be a little bit more detailed than SPAR in terms of
23 breaking down a system into different components. We
24 may not be as detailed in terms of the number of basic
25 events in the whole model, but we will capture all of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the main initiators and during our plant visits, and
2 during the MSPI evaluation process, we would add
3 support system initiators that are important.

4 MR. DENNING: Is it the human reliability
5 analysis you would expect to be in more detail or more
6 specific for the utilities PRA or is that not true?

7 MR. CHEOK: We would expect that the
8 utility PRAs would be more detailed than ours because
9 they will have access to their own EOPs and plant
10 procedures that we may not have access to.

11 MR. DENNING: And component failure data,
12 you didn't mention that, but that is another.

13 MR. CHEOK: Correct. The other thing, the
14 utilities would use plant specific data. We would use
15 our generic data for the whole industry for each plant
16 mode.

17 CHAIRMAN APOSTOLAKIS: Why?

18 MR. CHEOK: I think in a sense, that's
19 part of our standardization objective when we want to
20 compare results across the 72 plants. We would like
21 to think that it's not being influenced at this point
22 by plant specific data. We can obviously incorporate
23 plant specific data into our models, and we have done
24 that on event specific cases doing ASP analysis. When
25 we are analyzing a very specific event, we will apply

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 plant specific data if we think that it's appropriate.

2 CHAIRMAN APOSTOLAKIS: I mean, this
3 comparison across the industry is not very clear to me
4 because you can compare on the basis of CDF and LERF,
5 and the dominant contributors. You don't have to have
6 the same component failure distributions to say, oh,
7 now they're comparable. I mean, you do have the two
8 major metrics. So you could compare that way.

9 I mean, the whole idea is to have plant
10 specific PRAs, isn't it? The standardization can go
11 only so far.

12 MR. CHEOK: Well, we are trying to achieve
13 an optimum balance between standardization and being
14 plant specific, and I think -- and I don't want to
15 steal too much thunder from our INL staff. They will
16 discuss standardization to a lot bigger degree than I
17 am doing now, and I will sit in the side and we will
18 discuss this again later when they come up.

19 CHAIRMAN APOSTOLAKIS: Rich, did you want
20 to say something?

21 MR. DENNING: Yeah, I'll say it now. I'm
22 sure we're going to come back to it. I think it's
23 really a very interesting philosophical question as to
24 what the best direction is here, and at least from
25 where I'm sitting now, I really like the idea of using

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the generic data, but with sensitivity studies.

2 You know, you do the generic study and
3 then you look and see what did the plant itself really
4 predict for the similar thing, and then you try to
5 understand what the reasons are for the differences.

6 But again, I'm sure this is something
7 that's going to be an important philosophical question
8 for us.

9 CHAIRMAN APOSTOLAKIS: The generic data
10 may not apply to that plant.

11 MR. DENNING: Well, that's true, and I
12 think with sensitivity studies, I think you always go
13 back and try to understand, well, what's the
14 difference between --

15 MR. CHOKSHI: You're going to see some of
16 these as a part of the presentation as well, this kind
17 of comparisons, and we invite you to come back to this
18 point, I think, after you see this.

19 DR. BONACA: How do you deal with updates?
20 I mean, the plants change and they have data PRAs.

21 MR. CHEOK: That's an issue that we are,
22 in essence, struggling with. We update our models
23 each revision, Revision 2 or Revision 3 and enhanced
24 revision. As the plants update their PRAs, there is
25 really no requirement for them to come to us, to give

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 us what they use for the updates.

2 CHAIRMAN APOSTOLAKIS: Unless you have a
3 significant determination process.

4 MR. CHEOK: Correct, unless we have an SDP
5 or an ASP finding, and they will come and tell us,
6 "Oh, by the way, we changed this configuration and you
7 should do it," and we will do it at that time, but
8 there's no formal process at this point.

9 CHAIRMAN APOSTOLAKIS: The use of generic
10 data, of course, eliminates the influence of safety
11 culture, doesn't it?

12 MR. DENNING: Well, it certainly averages.

13 MR. CHEOK: I would agree that it averages
14 since it is generic data.

15 All right. Evolution of SPAR models.
16 SPAR models evolved from the two event trees we
17 originally used as art of our ASP program. We had one
18 event tree for PWRs and one for BWRs. In Revision 2
19 we basically went to a 72 model set, one for each
20 plant site. It linked fault trees and event trees.

21 In Revision 3 we had support systems, more
22 initiating events, and uncertainty analysis
23 capability. In this case we basically have
24 uncertainty distributions for each of our parameter
25 estimates and subjected the models to benchmarking

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 against the licensee's PRA.

2 And we are now working on low power
3 shutdown, external events and LERF models as part of
4 the effort.

5 CHAIRMAN APOSTOLAKIS: Now, all of these
6 models are in SAPHIRE, right?

7 MR. CHEOK: All of these models use the
8 SAPHIRE code engine to run. That's correct.

9 CHAIRMAN APOSTOLAKIS: Now, you know that
10 several years ago there were proposals from Franz to
11 go to BDDs, binary decision of Bayesian decision
12 diagrams or binary decision diagrams, and slowly that
13 approach is catching up in this country.

14 I was informed that a few weeks ago there
15 was an EPRI report that was issued on BDDs. Now, I
16 realize that switching to a new code is going to
17 create a lot of problems for you because you already
18 have the models, and so on.

19 On the other hand, wouldn't it be a good
20 idea to have a small project somewhere where a team of
21 you guys looks at this new approach and decides, you
22 know, what we're doing is good enough or we may do
23 this ten years from now.

24 What bothers me about it is that, you
25 know, a lot of people especially at conferences talk

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 about these things, and we, the agency, seem to be
2 oblivious to all of that or we're rejecting it out of
3 hand.

4 The truth of the matter is that they claim
5 you don't need cutoff frequencies, okay, because you
6 can solve the exact problem. There is a price you pay
7 for that, of course. One is that I don't believe
8 they produce minimal cut sets automatically. You have
9 to do some things together, which, of course, for us
10 is a major drawback because we really want to
11 understand the modes of failure.

12 But I would suggest that you gentlemen get
13 a copy of this EPRI report. I have it electronically
14 if you want it.

15 MR. CHEOK: Yeah.

16 CHAIRMAN APOSTOLAKIS: Oh, you have it.

17 MR. CHEOK: No, if you can send it.

18 CHAIRMAN APOSTOLAKIS: Sure. I'll give it
19 to Eric, and maybe, you know, some time in the future
20 next year you come back and say, "Yeah, we
21 investigated it. We analyzed it, and we concluded A,
22 B, C."

23 You may very well conclude that what
24 you're doing is good enough, but at least we'll have
25 some ammunition to defend it, considering, of course,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the effort it would take to change all of these models
2 out to a new code. I mean, the benefit, cost-benefit,
3 Nilesch, I mean, these are new ideas for this agency,
4 right?

5 The record should show that I was smiling
6 when I said that.

7 (Laughter.)

8 CHAIRMAN APOSTOLAKIS: Okay, Mike.

9 MR. CHEOK: All right. As Nilesch said
10 earlier, our branch does offering experience risk
11 assessments, and this is an integrated effort. We
12 know that we analyze data in three cuts. The first
13 cut is at the industry-wide performance level, and we
14 do that in terms of industry-wide performance trends.

15 A second cut is to provide plant specific
16 performance indicators.

17 And the third cut basically is to go even
18 one level below, and that's to analyze the risk
19 significance of operating events. So where do we
20 begin?

21 At the beginning of this chart we collect
22 data from sources such as the licensee event reports,
23 the monthly operating reports, the INPOs/EPICs
24 database, and FAR events from various sources, and we
25 do look at the ROP, reactor oversight process, input

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 from SSUs and now MSPI.

2 We collect and code this data using our
3 integrated data collection and coding system and input
4 this data into our RADS database and our CCF database.

5 We also input all our data into the NRC
6 Website to be available for all staff to use. We are
7 in the process of putting this Web site to be
8 available for external stakeholders.

9 We use this data in our SPAR models, and
10 we use our SPAR models and our data, like I said
11 earlier, in several programs, the industry TRANS
12 program, the ROP, the ASP program, inspection
13 programs, and in licensing reviews.

14 CHAIRMAN APOSTOLAKIS: What is RADS?

15 MR. CHEOK: I'm sorry?

16 MR. CHOKSHI: Reliability and data --

17 MR. CHEOK: RADS would be --

18 CHAIRMAN APOSTOLAKIS: Can you go back?

19 MR. CHEOK: Back? How do I do that?

20 CHAIRMAN APOSTOLAKIS: There's another
21 arrow. One more.

22 MR. CHEOK: Yes. Okay. RADS?

23 CHAIRMAN APOSTOLAKIS: Yeah.

24 MR. CHEOK: RADS would be the reliability
25 and availability data system.

1 CHAIRMAN APOSTOLAKIS: And availability
2 data. Now, I think that when one implements the
3 significance determination process, one really needs
4 details, doesn't it? Because these are findings that
5 are not typically in PRAs.

6 Is that when you take your SPAR model and
7 then you work with a utility to make sure that that
8 detail is there?

9 MR. CHEOK: We try to do that. To the
10 extent possible we will basic -- our staff in the
11 regions and NRR would use the SPAR models to come up
12 with the finding, and in many cases -- I would say
13 most cases -- it would match what the licensee would
14 come up with.

15 CHAIRMAN APOSTOLAKIS: Now, this process
16 has three phases or something.

17 MR. CHEOK: That's correct.

18 CHAIRMAN APOSTOLAKIS: Phase three is the
19 most detailed one.

20 MR. CHEOK: That's correct.

21 CHAIRMAN APOSTOLAKIS: That's when the
22 licensee possibly disagrees with you, and they want to
23 argue that, you know, things are not the way you
24 think.

25 So I assume at that level you really have

1 to go down to the details.

2 MR. CHEOK: Well, not quite. Phase two is
3 basically the use of notebooks, plant notebooks.

4 CHAIRMAN APOSTOLAKIS: Yeah.

5 MR. CHEOK: And then phase three is when
6 we say phase two is a little bit too conservative.
7 Let's do a PRA model.

8 CHAIRMAN APOSTOLAKIS: Yeah, that's what
9 I mean.

10 MR. CHEOK: And in that case we will do
11 our own SPAR model analysis and the licensees in most
12 cases would do their own analysis using their own
13 models, and as I said earlier, in many cases they
14 would actually match, and the results would be the
15 same.

16 If they are not the same, then we would
17 try to reconcile the differences, and at that point,
18 you know, we would make changes to the SPAR models or
19 perhaps even suggest to the licensee that their PRA
20 models are different because of certain things.

21 CHAIRMAN APOSTOLAKIS: Do we know off hand
22 how many cases like that you have? I mean, does that
23 happen routinely or is it very rare?

24 MR. CHEOK: I think I'll defer this to Don
25 Marksberry. He works a lot more with the ASP

1 analysts.

2 In terms of phase three analysis, are you
3 talking about how often we use the SPAR models or how
4 often --

5 CHAIRMAN APOSTOLAKIS: How often do you
6 disagree with a utility?

7 MR. CHEOK: I guess we'll get you the
8 statistics, George, but I don't have it off the top of
9 my head.

10 John. John might know.

11 MR. LONG: My name is Steve Long. I work
12 in the Office of Nuclear Reactor Regulation, and I do
13 some of the significance determination modeling.

14 Basically if the results are not green, we
15 usually end up in a discussion with the licensee. A
16 lot of the argument comes down to not what is in
17 either the licensee's IPE or a SPAR model, but in some
18 particular aspect that's not really a detail yet
19 modeled and how to model that. The worse the color,
20 the more arguments we get into, but there's quite an
21 incentive to get a green if you're a utility company.

22 So there's almost always some sort of
23 discussion back and forth on the modeling anything
24 that's not green.

25 CHAIRMAN APOSTOLAKIS: So it's not that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the utility's model is more detailed. It's that
2 usually both models don't have some detail that the
3 utility feels is important.

4 MR. LONG: Well, some things will turn out
5 to be green because we will look at the utility's
6 model and we'll figure out that we like the way they
7 model it and we agree that it gives the right answer
8 or reasonable answer and it's green and the discussion
9 is over.

10 CHAIRMAN APOSTOLAKIS: But wouldn't you
11 change the SPAR model then?

12 MR. LONG: The SPAR models are not really
13 a collection of everything we've ever done in the past
14 for a particular plant because you end up with a lot
15 of detail which is done on sort of an ad hoc way,
16 maybe not a very complete way, and it's not uniform
17 across the model in that level of detail. You're just
18 going down deep in one thing for one particular set of
19 conditions so that you've already sort of solved the
20 model. You've focused on certain sequences. You
21 maybe have focused on certain cut sets, and now you're
22 just extending the modeling for those particular
23 sequences or cut sets.

24 And the way you've done that may not even
25 be applicable for a full model solution. So you just

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 have to be careful, and we would create an intractable
2 problem, I think, for our contractors if every time
3 that was done we told them to maintain that at a
4 quality level. Then from then on we would quickly
5 build up a morass of details that you couldn't count
6 on for the next event actually modeling the situation
7 accurately.

8 CHAIRMAN APOSTOLAKIS: Okay.

9 MR. LONG: Does that make sense?

10 CHAIRMAN APOSTOLAKIS: Go ahead. That's
11 fine. Thank you.

12 MR. CHEOK: John Schroeder from INL will
13 report some insights on this. When we have a SPAR
14 model help desk, so to speak, and when analysts from
15 the headquarters or from the regions have problems or
16 have differences with the licensee models, they could
17 call INL for some guidance, and John can give you some
18 input.

19 DR. SCHROEDER: Yes, I can offer a couple
20 of comments on that.

21 CHAIRMAN APOSTOLAKIS: Name, please.

22 DR. SCHROEDER: John Schroeder, Idaho
23 National Laboratory.

24 I provide a lot of support to the region
25 personnel when they enter into these conferences, and

1 what often happens is that the licensee comes to the
2 table with a set of cut sets that they believe
3 reflects the risk from the condition or the event, and
4 the SRAs have another set of cut sets that have been
5 produced by the SPAR model.

6 And in the cases where those disagree, and
7 how often that happens is probably -- I mean, we get
8 calls on this sort of thing probably at least one or
9 two a month, sometimes it may be only one and a
10 quarter, but frequently there are issues, and what
11 will happen is the SRA will look very closely at the
12 cut sets and there will be recoveries. There will be
13 system alignments represented in the licensee cut
14 sets, and the SRA typically comes from an inspection
15 background. So they will use their inspector's
16 skepticism and investigate those things.

17 And those things that they buy off on will
18 be fed back into the SPAR model to readjust their
19 result, and if those things have generic
20 applicability, they'll go into the baseline model and
21 stay there.

22 If it's a special case, unusual details,
23 a one time only type circumstance, then those things
24 will be discarded and not maintained.

25 CHAIRMAN APOSTOLAKIS: So by and large

1 then your team, Nilesh, is satisfied with the current
2 state of the SPAR models. You don't expect any
3 revolutionary change any time soon.

4 I mean, we all appreciate that here and
5 there you have to tweak the model a little, but by and
6 large, you believe that every unit in the United
7 States now has a good SPAR model for internal events.

8 MR. CHOKSHI: I think so. You know, the
9 process you have implemented, I think, is working out.

10 CHAIRMAN APOSTOLAKIS: Okay. How many
11 years did it take to get there?

12 MR. CHOKSHI: Oh, that --

13 MR. DENNING: How many man-years?

14 CHAIRMAN APOSTOLAKIS: Calendar years. I
15 mean, started what, in the early '90s?

16 MR. CHOKSHI: Looking for that, Don.

17 MR. MARKSBERRY: Don Marksberry, Office of
18 Research.

19 It started around 1994 with the Rev-1
20 models, and the total cost so far is \$7.2 million for
21 the iterative approach, and each time we went to a rev
22 model we were happy at that time, and then something
23 new comes about, and then we up the details of the
24 model to fit.

25 CHAIRMAN APOSTOLAKIS: Something new in

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 what sense?

2 MR. MARKSBERRY: Different purposes, such
3 as the ESP program. We wanted higher fidelity models
4 to do more analysis.

5 DR. BONACA: That's a bargain.

6 CHAIRMAN APOSTOLAKIS: Seven million?

7 DR. BONACA: Yeah.

8 CHAIRMAN APOSTOLAKIS: Reported in the
9 context of what we spent elsewhere.

10 DR. BONACA: I have a question. We heard
11 about cases where there are disagreements. There are
12 a lot of disagreements, except for minor details, and
13 the observations that you draw from SPAR are agreed to
14 by the licensee.

15 What's the success rate?

16 MR. DENNING: Let me ask a slightly
17 different question maybe, and that is, you know, you
18 looked at kind of the general agreement at the high
19 level, CDF level, and now you're looking at the cut
20 set level. Do you see significant differences? As
21 you look intensively at cut set level, do you see
22 significant differences that require modification?

23 DR. SCHROEDER: This is John Schroeder
24 again.

25 Some of the plots that we'll present later

1 on in the presentation address this in a global way.
2 We see a lot of differences and big differences in
3 relatively unimportant components. We see very few
4 differences in really important events because from
5 the beginning of the SPAR model development process,
6 we have been trying to calibrate our models against
7 what is risk significant, and the more we learned, the
8 deeper we had to go.

9 So what you'll see in the importance
10 comparison plots is a triangle where there's tight
11 agreement on very important events and increasing
12 scatter as we move down into very low importance
13 events.

14 Now, the issue becomes when you do a
15 significance determination or ASP analysis that the
16 baseline risk or the conditions in effect for the
17 analysis change what is important, and that requires
18 a certain attention to those low probability events
19 that wasn't received early in the program, and that
20 generates the discussions and the investigations on
21 the part of the SRAs, and that generates modifications
22 to the SPAR models.

23 CHAIRMAN APOSTOLAKIS: Okay.

24 MR. CHEOK: Okay. The next slide would be
25 the users of the SPAR models, and we have already

1 discussed a lot of this. Obviously we use it as part
2 of the SDP Phase 3. We use it in ASP analysis. We
3 use it to improve the quality of PRAs through the ASP
4 program, through MSPI.

5 You know, we find a lot of things that may
6 or may not be modeled in current PRAs. For example,
7 common cause interactions of events and operator
8 recovery actions. These are things that we notice
9 through use of the SPAR models, and we can feed it
10 back to our models and to the licensee models.

11 We use it to perform analysis in support
12 of generic safety issue resolution. For example, on
13 GSI-189, which is the combustible gas control issue
14 and GSI-191, which is the PWR sump issue, we use it to
15 support risk informed reviews of licensing amendments,
16 and we use it to provide an independent capability to
17 evaluate risk issues across plant populations. For
18 example, the MSPI effort and also the LOOP/SBO study,
19 which the subcommittee has reviewed.

20 Agency interfaces. We involve our users
21 a lot for the SPAR model development process. The
22 SPAR model users group, SMUG, was formed in 1999, the
23 members from Research, NRR, and the regional offices.
24 This group basically provides the direction for how we
25 develop our SPAR models. They form the SPAR model

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 development plan, and this plan has been approved by
2 all user management organizations.

3 We currently have two NRR user need
4 requests for SPAR model development. We attend SRA
5 counterpart meetings twice a year to perform training,
6 to provide guidance on the use of SPAR models. I
7 think this is important. It think it's very important
8 to continually train our users.

9 Two, I think it's very important for us to
10 continue to update our models depending on what the
11 users want and what they tell us they want.

12 And I think it's important to get feedback
13 from all of our users.

14 DR. KRESS: Do you have severe accident
15 models in SPAR with fission products?

16 MR. CHEOK: We currently do not have
17 fission product severe accident models. We have the
18 LERF models, but that ends in a release, and we do not
19 have --

20 DR. KRESS: Are there any plans to go in
21 that detail?

22 MR. CHEOK: Well, not in the SPAR program.
23 I think there are other programs that may go into that
24 arena, but not through SPAR.

25 DR. KRESS: So you would never then

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 consider Level 3 either?

2 MR. CHEOK: I guess I wouldn't say
3 "never," but we are not considering that at this
4 point.

5 And again, the last bullet basically says
6 that we do have a help desk which John Schroeder
7 talked about where all SPAR users can call us for
8 support when they need it.

9 Program development activities, and I'll
10 go through these quickly. In Level 1 internal events
11 at full power, we do have 72 Revision 3 SPAR models
12 available, and we are in the process of enhancing
13 these models, and we'll talk about these today.

14 We have low plant shutdown models. We
15 have ten models completed with on-site QA for four
16 models completed. We intend to have four more
17 completed in FY '07. We will talk about these
18 tomorrow.

19 The Level 2 largely released frequency
20 models, we are intending to complete ten models by
21 2008 for the ten lead plant classes. Currently we
22 have three models completed, and for external events
23 which covers fires plus seismic events, we currently
24 have six models drafted. This is the most recent of
25 our efforts. We are in this for six months. We have

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 six models done, and will continue to refine the model
2 development process as we go along.

3 MR. DENNING: One thing I'm not
4 understanding here is what are your objectives. I
5 know it's difficult to go back, but go back to the low
6 power shutdown models. Do you plan to have a low
7 power shutdown model eventually for every plant?

8 MR. CHEOK: At this point, no. We
9 probably will end up with between 15 to 20 models. As
10 Nilesh said earlier, these models are very dependent
11 on our reactions with the licensees, and whether they
12 have staff that can help us out in these models,
13 especially in cases like low power shutdown, which are
14 very plant specific.

15 If licensees do not have these models, it
16 will make it harder for us to come up with models of
17 our own.

18 DR. BONACA: But wouldn't your developing
19 these models spur the licensees to develop their own?

20 MR. CHEOK: It may. You're right. I
21 mean, the fact that the licensees think that the staff
22 has one, maybe they should have something that would
23 I wouldn't say counteract, but to have their own
24 models, but I guess I kind of answered that for sure.

25 DR. THADANI: I think it seems to me,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 Mario, that that's an important point because the PSA
2 conference in September, NEI, indicated that they
3 thought that the low power shutdown models were not
4 that important, that they had lower priority.

5 And so I think this could be an
6 important --

7 CHAIRMAN APOSTOLAKIS: Because they have
8 a lot of human actions, and we know that human actions
9 are very reliable.

10 DR. THADANI: Yes.

11 MR. DENNING: I mean, obviously one of the
12 issues is can you get the funding to do it. I mean,
13 obviously there is an issue here, and I think it's an
14 issue that, you know, the ACRS doesn't get directly
15 involved with, other than if we recognize the need,
16 then we make a lot of noise about it, and so as we
17 look at the low power shutdown and also the external
18 events and this type of thing, I mean, my own feeling
19 is that they are extremely important and that our
20 objective should be to have each of -- SPAR covering
21 each of these models and then the question is are
22 there really enough funds to do it, as well as keeping
23 everything updated and this kind of stuff.

24 But I'm curious as -- and you gave a good
25 answer as to why it's difficult to do this, but it

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 does seem to me that our objective should be to have
2 a full complement for every plant, and I'm curious.
3 Is that what you really think?

4 MR. CHOKSHI: And I think you will see
5 that, you know, maybe as you'll pulling through that
6 one of the objects is to sort of see if there is a way
7 to develop those things, and how robust and how
8 useful, and you will see in some of the detailed
9 presentations the type of issues that come up, you
10 know, how you can be sure that it's capturing enough
11 plant specific features.

12 They're so plant specific, externally --

13 DR. BONACA: And that's a decision, I
14 mean, depending on how the average is being managed.

15 MR. CHOKSHI: And what applications we are
16 trying to make of it.

17 CHAIRMAN APOSTOLAKIS: So the goal here is
18 to have eventually a good set of Level 1 and Level 2
19 full power and low power shutdown model for each
20 plant. Is that the goal?

21 MR. CHEOK: The goal is to have enough
22 models that we can use, and I was going to answer your
23 question that way, that we can use on a regular basis
24 to assess events or to help in licensing applications.
25 As we go along, we may find that we are depending a

1 lot more on our lower power shutdown models or a lot
2 more on our external events models, and if that's the
3 case, then it would give us the justification to
4 continue to develop these models for the full set of
5 plans.

6 But, on the other hand, we do not use
7 these models as much and we can adapt one model or one
8 plan to the next plan in the time we need to use it
9 and perhaps we will stick with a representative step.

10 CHAIRMAN APOSTOLAKIS: You are talking
11 about the mechanics of doing it.

12 MR. DENNING: Well, maybe, George, but the
13 question that you've raised, I mean, that was exactly
14 what got us into this discussion, is we looked and saw
15 that as far as their established goals, they're much
16 more limited than saying we're going to have one for
17 every operating plan, and that's the question. Is it
18 necessary? Is it a technical -- and I guess we're
19 hearing kind of two sides of this. One is that not
20 all of the plants have them or a lot of the plants
21 don't have them so that it makes their job that much
22 more difficult to develop them.

23 But then I guess the most recent just made
24 is perhaps if you look at classes of plants and have
25 models for those, that when you get to the other

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 specific one, you can do that.

2 But let me make one more point and that is
3 that as the ACRS looks at these various risk informed
4 decisions that are being made now, virtually every
5 time we address that the question arises as have they
6 really also looked at -- and everything is oriented
7 towards internal events, and you say, "Well, have they
8 really looked at low power shutdown? Have they looked
9 at seismic? Have they looked at fire risk?"

10 And the answer is no a large fraction of
11 the time, and we certainly aren't comfortable with
12 that situation at the moment.

13 DR. BONACA: But it seems to me one thing
14 that one could certainly gain from this number of
15 models of low power shutdown is an understanding of
16 whether practices used in different plants, a similar
17 design may make a difference to risk because really we
18 don't know that exactly.

19 Now, I'm not at all familiar with -- I'm
20 not saying that they are all using different
21 approaches to the refueling, but there are
22 differences, and that would be certainly an important
23 objective.

24 CHAIRMAN APOSTOLAKIS: Yeah, because
25 unless I misunderstood you, one of the major results

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 of the flurry of activities in the '80s and '90s to do
2 PRAs was that they have to be plant specific because
3 there are features in one plant that you don't find in
4 another.

5 You know, there's something bothering me
6 about this continuing debate on whether low power
7 shutdown models should be developed, and we'll see if
8 there is a need. I recall there was a report, a very
9 good report, in fact, that was developed as part of
10 the ATHENA project several years ago that listed all
11 sorts of human errors during shutdown operations.

12 So how do we do a significance
13 determination process for these? I mean, if we don't
14 have the model, it seems to me we're going to arm wave
15 a lot, and in other words, there is evidence that
16 stuff happens during low power shutdown, and because
17 of the state of the plant, it may be more risky.
18 Right?

19 So it seems to me that there is an
20 incentive to do this. Now, again, Michael started
21 talking about the mechanics of it and the resources
22 and so on, but maybe if you start using your models
23 which may be crude at the beginning, then the
24 licensees will see the light and say maybe it's
25 worthwhile developing something more detailed here.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. CHOKSHI: I think, yeah, that's
2 important. We are learning more and developing as we
3 apply to the situations, I think, and this is what
4 we're waiting to see.

5 CHAIRMAN APOSTOLAKIS: But my point,
6 Nilesch, is that there is evidence. First of all, one
7 major piece of evidence is that PRAs have shown that
8 the contribution to core damage frequency from low
9 power shutdown operations is comparable to that from
10 power operations. That's already a major incentive,
11 and the second one -- in fact, I think that was the
12 last time when the PRA community was surprised by a
13 result, about 15 years or so ago. All right? That
14 was a surprise.

15 And second, as I said, you know, there is
16 evidence, I mean, produced by this agency that a lot
17 of things happened there and because, you know, the
18 vessel may be open and so forth. It's important to
19 understand those and have a tool to evaluate them.

20 MR. CHEOK: And I think the agency
21 supports the CRS obviously in terms of --

22 CHAIRMAN APOSTOLAKIS: Do you have any
23 evidence for that?

24 MR. CHEOK: If you look at Reg. Guide
25 1.174 and 1.200, it basically states that we should

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 consider all modes of operation and everything else,
2 and it's our job, I guess, to provide the tools for
3 the staff to be able to carry out --

4 CHAIRMAN APOSTOLAKIS: Mike, you're
5 touching a sore point with me because we always use
6 those words "consider."

7 MR. CHEOK: That's correct.

8 CHAIRMAN APOSTOLAKIS: Since 1998 when the
9 regulatory guide came out, and that word has more
10 meanings in the English language than any other word.

11 DR. KRESS: Let me make a comment about
12 low power and shutdown tools. There's two types of
13 low power and shutdown risk. If you're doing a
14 significance determination process, you have a good
15 idea of the plant configuration and you can do that
16 for given events for a given plant, but a lot of the
17 need for low power and shutdown risk is to have just
18 like we do with full power an integrated risk over the
19 lifetime of the plant. This is what we end up with.
20 We do it on a per year basis, but it's actually an
21 integrated risk over the lifetime of the plant.

22 Now, over the lifetime of a given plant,
23 the configuration during shutdown varies markedly over
24 different configurations for different times. Now, in
25 order to actually model that in a low power and

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 shutdown risk, that you're interested in that aspect
2 of it, you're going to have to have a database.
3 You're going to have to go to all of these plants and
4 look at how long they're out, what equipment is out,
5 and get some sort of a database on all of these
6 configurations and somehow average them or get plant
7 specific ones, and that doesn't look like an easy task
8 to me. It looks like a development of PRA that's
9 needed, and nobody seems to be working on that part of
10 it. That's what bothers me.

11 MR. CHEOK: I think we agree with you.
12 It's a challenge and to get it to be plant specific
13 enough to give us good insights for the overall risk
14 and even for evaluating events as they arise because
15 they are so plant specific and so issue and event
16 specific.

17 MR. CHOKSHI: I think you will also see it
18 in the schedules, why it takes so long to develop, and
19 you know, it's also a burden on QA with license
20 established, much more involved for low power and
21 shutdown. So that's I think the simple point in that
22 availability of licensing staff may not convey that,
23 but it's a major effort.

24 CHAIRMAN APOSTOLAKIS: What do you mean
25 contingent on availability? Just start using it.

1 PARTICIPANT: That's the QA part of it.

2 CHAIRMAN APOSTOLAKIS: Just start using
3 it. You know the recommendation from President
4 Johnson.

5 MR. CHEOK: All right. Are we ready to
6 move on?

7 Related topics -- I'm sorry.

8 DR. KRESS: Before you move on I notice on
9 the previous slide your focus, probably rightly so, is
10 on LERF, but quite often this committee is interested
11 in late containment failures, or maybe even the
12 conditional containment failure probability.

13 Now, that is a little harder to analyze
14 because with LERF you can do this Brookhaven
15 simplified approach which just requires thermal
16 hydraulics, but for late containment failure you're
17 going to need a different approach, I think, and I
18 think somewhere along the line you need to start
19 thinking about adding late containment failures to the
20 SPAR models.

21 MR. CHEOK: We have -- and I guess John
22 will talk about this tomorrow a little bit more -- our
23 LERF models defined such that we can proceed to the
24 late containment failures and the large lates quite
25 easily so that the endpoints are there.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. KRESS: Yeah, I don't want --

2 MR. CHEOK: It's just not developed.

3 DR. KRESS: -- our conditional containment
4 failure probability, which includes large and small.

5 MR. CHEOK: Right.

6 DR. KRESS: But I think these are good
7 things to think about, how to model.

8 MR. CHEOK: We have thought about it, and
9 like I said, the capability is there to expand to the
10 large lates.

11 Related topics, and George brought this up
12 earlier. The SPAR model development process is very
13 closely linked to the SAPHIRE code development and
14 SAPHIRE Revision 8 will be an important tool for using
15 the latest SPAR models. We will demonstrate the
16 SAPHIRE and SPAR models a little bit later today.

17 And proposed future ACRS presentations.
18 In December we'll be coming back to talk to you all on
19 the SPAR-H methodology as part of your HRA
20 subcommittee meetings. We are proposing that in the
21 summer or spring of next year that we would come to
22 you to talk to you about our collection of data and
23 how we use industry data and SPAR models and in the
24 rest of our programs. Again, we will work that out
25 with you if you're interested.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 And Dr. Sieber recently had inquired about
2 a staff briefing on SECY 05-0129, which is our annual
3 SECY on the status of the SPAR and ASB programs.
4 Again, if the committee is interested we can come back
5 at your request.

6 CHAIRMAN APOSTOLAKIS: Yes. In fact, I'm
7 glad that you have your schedule up there because I'm
8 sure we will discuss this later, but we plan to be
9 involved in your activities as much as we can and give
10 whatever advice we can.

11 So perhaps after the review of this
12 subcommittee meeting, you will come to the full
13 committee meeting at some point where, February? And
14 maybe we can have a letter then on the overall
15 program, and then maybe we can have individual
16 meetings, especially SPAR-H.

17 I have great interest in SPAR-H, and then
18 write individual letters as appropriate.

19 MR. CHOKSHI: Yeah, because I think during
20 the discussion a lot of talks about what we should be
21 looking at and what are this -- it is sort of best if
22 captured in ACRS later and then maybe coming to full
23 committee we can, you know --

24 CHAIRMAN APOSTOLAKIS: Absolutely,
25 absolutely, but I think it's a model that -- it's an

1 effort, not just a model; it's an effort on the part
2 of the agency that is becoming now central to the
3 agency's activities, and I think we will all benefit
4 by having this exchange maybe every three, four, five
5 months.

6 MR. CHEOK: Okay. I'd like to turn this
7 over to INL for presentations.

8 CHAIRMAN APOSTOLAKIS: Which I hope will
9 finish faster than you, Mike. You're always so slow.

10 (Laughter.)

11 CHAIRMAN APOSTOLAKIS: So slow.

12 MR. DENNING: Did you notice how clever he
13 was that he planned just enough time even though we
14 dragged it out? I think he's right on schedule.

15 CHAIRMAN APOSTOLAKIS: He's right on
16 schedule. Oh, if he's been here before.

17 Oh, this is nice. This is part of SPAR?

18 DR. KRESS: Oh, throw that in.

19 DR. BUELL: That's Idaho.

20 MR. DENNING: It's not like Idaho today.

21 DR. BUELL: I'm Robert Buell from the
22 Idaho National Laboratory and this is John Schroeder,
23 and we're here just to provide some overview and some
24 depth of discussion for the SPAR modeling project,
25 some of the history and as well as some of the issues

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that we're working on now and possibly some future
2 tasks.

3 DR. KRESS: You guys lost your two Es.

4 DR. BUELL: Yes.

5 DR. KRESS: Good, good.

6 DR. BUELL: We're just a laboratory now.

7 So anyway, we were asked to talk about the
8 SPAR models and where we've been. We've broken that
9 down into seven topics that's on your agenda. You
10 have those seven topics. They deal with standardized
11 structure, and that's what I'm going to be presenting
12 right now. Then we go into a model demonstration that
13 John will present, and then I'll come back and do
14 major assumptions in our modeling of the SPAR models,
15 as well as some of the quality review procedures and
16 techniques that we use as we develop these SPAR
17 models.

18 We also have some of the modeling issues
19 that we've found. We've been around as part of the
20 STP plant visits, and we've gathered a lot of
21 intelligence, a lot of insight from looking at a broad
22 cross-section of the PRAs out there, and we're trying
23 to incorporate some of that into our models also.

24 And then John will talk about modeling for
25 uncertainty, some of the uncertainty issues that we've

1 identified and how we're dealing with those.

2 And then finally if we have time we'll
3 just give you a sample of our model documentation and
4 what we do there.

5 CHAIRMAN APOSTOLAKIS: Yeah, the modeling
6 parameter uncertainties are of particular interest to
7 this committee. And I've seen a write-up of nine
8 models where you describe how you reconcile the
9 differences between your --

10 DR. BUELL: We'll make sure to save plenty
11 of time for that then.

12 CHAIRMAN APOSTOLAKIS: So there should be
13 plenty of time for this, yes.

14 DR. BUELL: Okay, good.

15 CHAIRMAN APOSTOLAKIS: Because finally
16 somebody is looking at model uncertainty.

17 DR. BUELL: We look at both the parameter
18 uncertainty and the structural and John will go into
19 that in a little more detail.

20 CHAIRMAN APOSTOLAKIS: I know you do.
21 Parameter uncertainty is not that crucial.

22 DR. BUELL: Okay. Just a brief
23 background. You've already heard some of this, but
24 this is just history. Basically this whole program
25 even though it wasn't the SPAR models per se, but it

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 had its genesis back in the late '70s with the daily
2 events manual. That's when we started in some sim.
3 flight event trees that had split fractions.

4 We took that and used that as a starting
5 point and converted that into the SPAR 2QA models
6 after we had a review of Sandia. That became the 2QA
7 models.

8 At that point they did not have any
9 support systems. They had a very limited set of event
10 trees.

11 We took that to the next point in the 3I
12 models. We added additional event trees. We added
13 support systems. We also did a preliminary review by
14 going to all of the STP visits throughout the country.
15 We gathered information and additional insights during
16 that point.

17 We rolled all of that up into them, and
18 then we called them Rev. 3 models at that point.

19 CHAIRMAN APOSTOLAKIS: So this is what we
20 have now.

21 DR. BUELL: What we have now are Rev. 3
22 models. That is correct.

23 CHAIRMAN APOSTOLAKIS: And 3P is in
24 progress.

25 DR. BUELL: That is in progress. Those

1 are the ones where we have done the detailed cuts at
2 level review.

3 As part of the Rev. 3, we didn't give it
4 a new rev. number, but we did go through all of the
5 models and add new steel LOCA information after the
6 log information was approved. We added that to all of
7 the models, the steel LOCA information.

8 We also went in and had a significant
9 effort to link all of the data to template events that
10 we could rapidly update in a batch routine. So now we
11 have the ability to go in and rapidly update all of
12 our data throughout the models, as well as the
13 consistency issue.

14 With as many analysts as we had working on
15 the project, as many data sources as we had, sometimes
16 there were some inconsistencies with in the data. By
17 linking them all, the templates having one master list
18 now, we're able to maintain a real consistent set of
19 data.

20 We also updated some of the -- as part of
21 the seal LOCA logic we went ahead and typed that we
22 updated some of the LOOP and SBL logic since they were
23 interrelated in many cases.

24 CHAIRMAN APOSTOLAKIS: So it seems that
25 you're extremely reluctant to abandon Rev. 3. I, 3,

1 and then P. When will you go to four?

2 DR. BUELL: Well, I will defer on that
3 discussion.

4 CHAIRMAN APOSTOLAKIS: That's part of --

5 DR. BUELL: Yeah, there's a lot of
6 discussion on that.

7 So anyway, right now we're on the Rev. 3.
8 The P stands for plus in this particular instance. We
9 just had to name it, and that has to do with the
10 detail reviews that we're in the process of doing now.

11 CHAIRMAN APOSTOLAKIS: Good, good. Let's
12 go on.

13 DR. BUELL: That's the history and the S
14 in SPAR stands for standardized now. It used to stand
15 for simplified back in the 2QA days. Now it stands
16 for standardized. There's some real advantages to
17 have standardized models, and some of them have
18 already been discussed, but one of the advantages is
19 you can use a single engine to drive these. Okay?

20 There's a variety of them out there, new
21 prod cath (phonetic), risk MAN, and some of the
22 secondary --

23 CHAIRMAN APOSTOLAKIS: What is it, GEM?
24 I used to know.

25 DR. SCHROEDER: Graphical evaluation

1 model. It's sort of like a macro environment tailored
2 to doing either event assessment or condition
3 assessment, and it's used typically for the Phase 3
4 STP.

5 CHAIRMAN APOSTOLAKIS: So it's what,
6 graphical?

7 DR. SCHROEDER: Graphical evaluation
8 module.

9 CHAIRMAN APOSTOLAKIS: Thank you.

10 DR. BUELL: So we have a common tool that
11 we can use. You can be trained on that. NRC has an
12 extensive training program to train on that particular
13 program so they can run all of the models as well as
14 the peripheral analyses that we do.

15 CHAIRMAN APOSTOLAKIS: Apparently the
16 industry is very much interested now in SAPHIRE
17 because I was approached by a company several months
18 ago, and they asked me specifically whether I had a
19 student graduating who knew SAPHIRE.

20 DR. BUELL: Well, with the MSPI program
21 there's a lot of interest in our models, and you have
22 to run them all, but also SAPHIRE has been developed
23 to the point now that it has a lot of capabilities
24 that it never used to have.

25 So one of the advantages of

1 standardization is also uniformity of the models. By
2 having uniform assumptions, uniform level of detail,
3 all of these uniform construction techniques you can
4 actually identify some of the real outliers as opposed
5 to in some instances in the industry you can make an
6 assumption that will obscure a lot of these
7 differences in the building of your models.

8 I mean, like I say, with having that
9 standard set of assumptions and such, you can identify
10 outliers and have some confidence that those are real
11 outliers as opposed to being based on assumptions.

12 One of the other key advantages of this
13 complete tool set and the uniformity of the models is
14 that we can do industry-wide looks. Let's say we want
15 to look and see how a particular failure rate affects
16 the overall industry or, you know, if we want to look
17 at initiating event frequencies and how they impact
18 the industry. We have the ability to run through
19 those now and just look at all 72 models in short
20 order and see what that does to the industry risk.

21 So next page there.

22 Some of the standardized elements I just
23 started. I just touched on some of those that deal
24 with methodology. It has been mentioned before that
25 we're a small event tree, large fault tree linked set-

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 up. Now if you see some of our BWR even trees you
2 might not they are small event trees, but they're
3 small event trees.

4 CHAIRMAN APOSTOLAKIS: What's small?
5 What's a small event tree?

6 DR. BUELL: Well, small event trees
7 typically is where you do not have the operator
8 actions and the conditional failures in --

9 CHAIRMAN APOSTOLAKIS: But you still have
10 the major headings.

11 DR. BUELL: Yes, you still have the major
12 headings, but you can collapse those down in some
13 plant PRAs to three or four nodes across the top, and
14 you do everything hidden in the rules and in the
15 combinations. We think we've struck an optimum
16 balance there as far as what you see in the event tree
17 versus what's hidden in fault trees.

18 CHAIRMAN APOSTOLAKIS: Right.

19 DR. BUELL: So anyway, we've got a
20 standard set of assumptions, too, that we use to build
21 or fault trees and our event trees, you know, the way
22 we do common cause modeling, what type of components
23 we model, what type of things that we exclude, you
24 know, that type of thing so that we have a standard
25 set of assumptions that we use when we build these

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 models.

2 Did you have a comment?

3 Okay. We also have a standard set of
4 initiating events, and that's based on published data.
5 NUREG 5750 was the origin of that. Since then a few
6 of the values have been updated, and that will be
7 talked about this spring in the data analysis section.

8 CHAIRMAN APOSTOLAKIS: Now, again, coming
9 back to the site specific nature of these things, in
10 the PRA that I was involved in, we always found that
11 the -- I mean, there was a standard list of initiators
12 there for PWRs and BWRs, 15, 20 or so, but there were
13 always two or three that were unique to that site,
14 like if a truck drives and hits something which in
15 other sites you didn't have.

16 How do you handle that?

17 DR. BUELL: Well, we'll get into that
18 later as a part of the detail at that level review.
19 Basically we have a threshold that if it's important,
20 you know, and we define important as one percent of
21 their contribution to their overall CDF, if they have
22 a unique set of initiators like that, we will add that
23 to ours and try to understand it well enough that we
24 can model that.

25 But anything that they show that's

1 important that's outside of our standard set of
2 initiators, we will add that. We try to capture all
3 of the risk associated at that time.

4 MR. DENNING: When you talk about generic,
5 if you look at like B&W plants and things like
6 integrated control systems and failure rates for
7 those, do you use that set of plants to come up with
8 generic for like BMW plants?

9 Because I know that, for example, there
10 have been periods in which they had a large number of
11 failures and then they improved them, and so
12 generically the failure rates of those are lower.
13 When you talk about generic, does that mean generic
14 for like B&W plants of a certain vintage or is it even
15 broader than that?

16 DR. BUELL: It's broader than that
17 typically. In some initiators the statisticians have
18 looked at this at INL when they generated this report,
19 and they've done all of the statistical magic on that
20 and looked at, you know, if there's any pools of data
21 that they should separate.

22 We have separated many of the initiators
23 by Ps and Bs. Obviously that's a logical break, but
24 beyond that typically we don't break it into any finer
25 groups than that, and like I say, that is based on a

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 statistical look by the statisticians at INL when they
2 generated this data.

3 MR. DENNING: And they don't see a
4 difference because it seemed to me that it really did
5 have a big impact on frequency of turbine trips, you
6 know, for just that particular --

7 DR. BUELL: Okay. Well, I can't speak to
8 the details of it. Like I say, the statisticians will
9 look at all of those issues and they felt they were
10 grouped at the appropriate level. So beyond that, I
11 don't have any insight on that.

12 And you notice I have a bullet there that
13 says no support system initiating event fault trees.
14 This is an issue that we're going to hit a little bit
15 later or address in a little later presentation
16 because this is an issue that at INL at least we feel
17 needs to be addressed in the industry, and we have
18 some feelings on that and some thoughts on that, and
19 we'll discuss that in a little bit more detail later
20 on.

21 Right now probably two thirds of the
22 industry uses initiating event fault trees for some of
23 their sports S (phonetic) initiators. The remaining
24 third use a point value just like we do at this point.

25 So anyway, that's a point that we're going

1 to discuss in more detail later.

2 The event trees, they're standardized to
3 a point. They were based on standard event trees that
4 came out of the groupings of the daily events manual,
5 but as we get more and more detail in the models and
6 we need more of that detail, we have to start taking
7 into account more and more plant specific differences.
8 So we I don't know if you'd call it deviate from that
9 standard, but it's basically we have to pick up
10 additional elements that are plant specific, and so we
11 add that to our event trees.

12 So they were reviewed in the two 2QA
13 level. We still use that as our standard, but, like
14 I say, as we come across plant specific instances that
15 need additional detail, we do add that into the event
16 trees.

17 Fault trees, the key systems, the diesel
18 generating system, the electric power system,
19 RCCI/HPCI, those type of systems are based on logic
20 that was put together as part of the system studies
21 performed at INL several years ago. So we have that
22 same standard set of logic there also.

23 Some additional standardized elements in
24 SPAR model, failure data, that's something that's
25 going to be talked about in much more detail in the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 spring. I just give you a highlight of that.

2 We recently changed to EPIX based data
3 when we're on to the templates.

4 Did you have a comment?

5 CHAIRMAN APOSTOLAKIS: No.

6 DR. BUELL: Okay. We recently
7 transitioned from basically old generic data sources
8 and the system study information to a common EPIX
9 based data set, and that 1998-2002 was a period of
10 interest that we use as the pool of data.

11 We have a standard common cause failure
12 methodology as well as application. The method you're
13 probably all familiar with based on NUREG 5485, the
14 alpha factor methodology. We use that completely
15 throughout the models.

16 Data, the data for the common cause
17 failure is the alpha factors themselves come from a
18 mixture of data sources.

19 CHAIRMAN APOSTOLAKIS: I'm just curious.
20 The alpha factor method produces long expressions for
21 the probability of failure of, say, two pumps in
22 parallel. Three it's even longer.

23 You use that expression?

24 DR. BUELL: That expression is used within
25 SAPHIRE. SAPHIRE takes that and manipulates that, the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 code itself, and gives us the appropriate number.

2 DR. SCHROEDER: There's a SAPHIRE plug-in
3 or module that automates those calculations. It
4 requires as inputs the independent events in a group
5 and the alpha factors for that group, and it generates
6 the common cause failure probabilities using the
7 methods from that NUREG. Those expressions are long,
8 and they're hard wired into the calculational module
9 that's good for six strains or a six strain group.

10 CHAIRMAN APOSTOLAKIS: So the multiple
11 Greek letter method is not used anymore.

12 DR. SCHROEDER: That is correct.

13 DR. BUELL: The module has the capability
14 to use that, but since all of the uncertainty
15 parameters associated with the common cause
16 calculation are calculated in terms of alpha factors.
17 We use the data as provided.

18 CHAIRMAN APOSTOLAKIS: Now, have you seen
19 a significant difference between the two models, the
20 results of the two models?

21 DR. BUELL: Actually we have, and in a
22 later slide we've identified ten significant issues
23 where there is either variability within the industry
24 or differences between us and the industry. The
25 common cause is one of those with this latest update

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 of the alpha factors. That has essentially went away
2 or been much reduced, but in the past we had common
3 cause factors that were significantly higher than the
4 industry.

5 CHAIRMAN APOSTOLAKIS: I know that the
6 alpha factor approach is more rigorous, especially in
7 handling the data, the information, but you lose that
8 nice feature of the multiple Greek letter of
9 communication where you say, you know, the base
10 failure rate is this. Now, you know, if this has
11 failed, at least one other component has failed. So
12 the probability is usually ten percent or something.

13 Then gamma is if two have failed; then at
14 least one more has failed. In the alpha model you
15 lose that, and it's not so nice. It's just an
16 expression.

17 DR. BUELL: Well, that's all rolled up
18 within that SAPPHIRE plus, but all of the mechanics and
19 the information needed to generate those are there,
20 but, yes, they're not quite as transparent.

21 CHAIRMAN APOSTOLAKIS: It's not easy to
22 communicate it.

23 DR. BUELL: That's correct.

24 CHAIRMAN APOSTOLAKIS: Now, you say you're
25 going to come back to this?

1 DR. BUELL: Yes, in later slides we deal
2 with this in much more detail.

3 CHAIRMAN APOSTOLAKIS: Okay.

4 DR. BUELL: Okay. The additional data
5 points or data that we've updated is lost at off site
6 power frequency and recovery data. This is an ongoing
7 effort right now or just recently at INL to update all
8 of that, and we've incorporated that into our models.
9 Back there is a NUREG pending just in very short order
10 with that new information in it.

11 And we used the SPAR-H methodology, NUREG
12 6883 for modeling our human errors.

13 CHAIRMAN APOSTOLAKIS: That's another
14 thing we're going to spend some time on, right?

15 DR. BUELL: Okay. We're going to spend a
16 little bit of time on it, but there's going to be a
17 more detailed presentation in December, I believe. So
18 that will be covered in detail at that point.

19 Okay. Next, please.

20 One of the big advantages of using this
21 standardized structure is that we can look across the
22 industry and we can do it in a relatively short order.
23 Right now once we set up a model or a query as far as
24 what we want to do to a model, we can utilize SAPHIRE
25 macros to run all 72. I can set it up, push the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 button on my computer and come back in four or five
2 hours, and we'll have an output. Now, you know, it
3 may not be the right output, but there's all this
4 tweaking you need to do.

5 But the bottom line is once you identify
6 a series of issues in short order, half a day, we can
7 end up with the results across all of our plants, and
8 that --

9 CHAIRMAN APOSTOLAKIS: I don't want to
10 take away your thunder, but it seems to me that even
11 if you had 72 plant specific models that utilize, say,
12 plant specific information, you could still produce in
13 a relatively short period of time an industry-wide
14 profile.

15 DR. BUELL: Oh, that can be done.

16 CHAIRMAN APOSTOLAKIS: What are we doing
17 here?

18 DR. SCHROEDER: Let me address that at
19 least in part. During the benchmarking process with
20 the SDP notebooks we went on site and we watched the
21 NRC question the licensees about what is your risk
22 profile given this failure or that failure. In
23 effect, we watched the licensees run these sensitivity
24 studies, and to ask them to generate a result for,
25 say, what happens when DGA has failed, they might

1 disappear into the back room half the morning.

2 Their models are complex, and they are
3 slow to run, and it requires a high level of
4 expertise, and even at the licensees, they may only
5 have one or two people on their staff that can do
6 these calculations.

7 Now we have something that's similar
8 enough across all models, and it runs fast enough that
9 we have a large number of people that are trained that
10 can do this. There is a body of expertise that can
11 make this happen rather quickly, and I would suggest
12 that licensees have nowhere near this kind of
13 capability to respond rapidly.

14 CHAIRMAN APOSTOLAKIS: That's not a matter
15 of the licensees having the capability. You should
16 have it.

17 DR. SCHROEDER: Well, we would have to
18 learn probably four different analysis platforms, and
19 there's dreadful details in how to actually accomplish
20 those calculations on each platform.

21 MR. DENNING: And you'd have to go and
22 independently do every one of them, whereas with this
23 common platform, it sounds like you may be able to
24 make some --

25 CHAIRMAN APOSTOLAKIS: But you give us

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 something.

2 MR. DENNING: But you give up something,
3 and that's part of what we have to discuss.

4 CHAIRMAN APOSTOLAKIS: That's what I'm
5 afraid of. Speed versus accuracy.

6 DR. BUELL: Well, these are detailed
7 models. It isn't that we're using an astandard model.
8 I mean we have detailed, plant specific models, and
9 I'll show you just a graph here in a moment of --

10 CHAIRMAN APOSTOLAKIS: Now, the seventh,
11 does that cover all units?

12 DR. BUELL: That is correct. Some of the
13 potential uses of this capability are some data
14 sensitivities, if you want to do some sensitivities
15 across the industry, MSPI importance measures. Let's
16 say you wanted to look at, you know, the mean diesel
17 importance across all the plants or unit specific
18 diesels or whatever. You can look at that on an
19 industry-wide basis and say, you know, this is the
20 impact of that change or that sensitivity, and I think
21 that's a significant issue.

22 Next page, please.

23 And this is the SBL study that just
24 recently or is to be published shortly. This is just
25 a graph that we pulled out of that. We've been

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 running these different scenarios and combinations,
2 but you can see it's got a CDF with an error band on
3 either 95.5 band on those.

4 I might say this doesn't mean anything
5 other than the fact that it's just an example of the
6 type of runs we can do in short order.

7 CHAIRMAN APOSTOLAKIS: What are we looking
8 at now? This is the 90 percent interval, right?

9 DR. BUELL: That's correct.

10 CHAIRMAN APOSTOLAKIS: And the mean value,
11 and the reason why there is plant-to-plant variability
12 here is the different number of diesels they have?

13 DR. BUELL: That's part of it. The number
14 of diesels, the seal types they have in their pump
15 seals, you know, the reliability.

16 CHAIRMAN APOSTOLAKIS: Is the loss of off-
17 site power frequency more or less constant across the
18 country?

19 DR. BUELL: That study has just come out,
20 and Jonathan, do you want to address that?

21 CHAIRMAN APOSTOLAKIS: I mean, that's not
22 the major driver I don't think.

23 DR. BUELL: No.

24 DR. SCHROEDER: It's not the major driver.

25 CHAIRMAN APOSTOLAKIS: I mean, there are

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 differences, but it's not the major driver.

2 DR. SCHROEDER: And I don't recall what
3 was used in this curve, but when they actually did the
4 loss of off-site power study, they looked very hard
5 for regional differences in recovery times and loop
6 frequencies, and they looked for differences by plant
7 design, and they looked for any kind of difference
8 that they could justify in the statistics, and they
9 ran some of those numbers, and they made a lot of
10 decisions about whether to represent the analysis with
11 generic data.

12 And if you wanted all of the rationale for
13 that, you'd have to get one of the people involved in
14 the study that's --

15 CHAIRMAN APOSTOLAKIS: So there is more
16 than an order of magnitude difference between the best
17 and the worst, right?

18 DR. BONACA: Two orders.

19 CHAIRMAN APOSTOLAKIS: Two?

20 DR. BONACA: Two almost, yeah.

21 MR. DENNING: But the way you treat it
22 now, there would be no difference in recovery time
23 regionally. Like a plant that is likely to have
24 hurricanes, potential for hurricanes, is not going to
25 have a different recovery time.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 DR. SCHROEDER: Right now in our base SPAR
2 models we do not differentiate that.

3 MR. DENNING: But you can always go in and
4 do that.

5 CHAIRMAN APOSTOLAKIS: So this graph then
6 represents which failures, failures that can be
7 restored in an hour and a half, two hours?

8 DR. BUELL: These are the ones that you
9 actually have a plant blackout. You've had a loop and
10 then you go to a plant blackout.

11 CHAIRMAN APOSTOLAKIS: Right. I
12 understand that, but this doesn't say for how long.

13 DR. BUELL: That's correct. Within each
14 one of these points you have some sequences that are
15 two hours. Some you have the equivalent to operate;
16 you might have four hours. So this is a composite for
17 all of those different sequences for each plant.

18 CHAIRMAN APOSTOLAKIS: Because as Rich
19 just said, if the loss of off-site power is due to an
20 external event, it may take days or even weeks to
21 restore it.

22 DR. BUELL: That's correct.

23 CHAIRMAN APOSTOLAKIS: Those losses of
24 power are included here.

25 DR. BUELL: That is correct.

1 CHAIRMAN APOSTOLAKIS: The duration is
2 not.

3 DR. SCHROEDER: The duration is. I'll
4 speak to that. We have rolled into the baseline loss
5 of off-site power model all classes of loss of off-
6 site power. The recoveries and the frequencies, while
7 the frequencies stand from what the statisticians gave
8 us, but the recoveries are frequency weighted.

9 And in the last iteration of the model, I
10 believe we're to four classes again. That's been
11 subject to a lot of change, three classes, five
12 classes, four classes.

13 MR. DENNING: But every plant gets the
14 same thing so that the South doesn't have a
15 different --

16 CHAIRMAN APOSTOLAKIS: This is the
17 probability that in any one year, Plant X will have a
18 station blackout.

19 DR. SCHROEDER: This is the frequency of
20 blackouts for Plant X.

21 DR. KRESS: Core damage.

22 MR. DENNING: Core damage frequency from
23 station blackouts.

24 CHAIRMAN APOSTOLAKIS: Yeah, core damage
25 from station blackouts.

1 DR. BONACA: Curiosity. Just you have a
2 small set of plants there with CDF on the order of
3 ten to the minus seven. It would be low. What is so
4 unique about those plants?

5 DR. BUELL: Well, there's a couple of
6 plants out there that have hydroelectric backup which
7 are extremely reliable, underground cables, those
8 types of things. So there's a few plants at that end
9 that have a unique configuration. It does account for
10 that.

11 DR. SCHROEDER: What you would see if you
12 started looking at the basis for that, and again, the
13 authors of the blackout study looked at that pretty
14 carefully, and they could tell you what's driving the
15 risk at each end, but you have a lot of plants in the
16 country that have four electrical division and
17 blackout generators and other aspects to their
18 emergency power system that drive it way down, whereas
19 at the upper end you might have a plant that has a
20 seal cooling weakness and only two divisions of AC
21 power and no auxiliary backups.

22 I mean, that's the spectrum of things out
23 there.

24 CHAIRMAN APOSTOLAKIS: Are the members
25 interested in pursuing this in more detail in the

1 future, this kind of study?

2 MR. DENNING: Yeah, but you know, that's
3 exactly what we did look at in the station blackout,
4 the specific one that we --

5 CHAIRMAN APOSTOLAKIS: We said there was
6 another report coming up.

7 MR. DENNING: Oh, it's something coming
8 up.

9 DR. BUELL: It's in draft stage right now.
10 It's waiting to be published, and this may be the one
11 that you're reviewing. I don't know.

12 MR. CHEOK: What the committee reviewed
13 was the draft report that was provided in February.
14 The final version of the report is coming out in
15 December.

16 CHAIRMAN APOSTOLAKIS: Oh, so it's the
17 report we reviewed. There is no more information.

18 MR. CHEOK: That's correct.

19 DR. BONACA: That to me shows the value of
20 SPAR very much here.

21 MR. DENNING: Absolutely.

22 DR. BONACA: You have the ability of -- in
23 fact, yes, I think it would be a good exercise.

24 CHAIRMAN APOSTOLAKIS: Well, they say we
25 reviewed it, but, again --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DENNING: Well, in a sense we've
2 already seen this example.

3 CHAIRMAN APOSTOLAKIS: But I think we
4 should go over it again, and maybe with the full
5 committee. This is important. But I don't know. The
6 worst plant is at what, one or two ten to the minus
7 six.

8 DR. KRESS: Several worse plants.

9 MR. DENNING: Why did you say that?
10 You've got one times ten to the minus five.

11 DR. KRESS: That's a fie, yeah.

12 CHAIRMAN APOSTOLAKIS: That's a five.
13 You're right. And we get that even though we have a
14 station blackout rule. Huh. I wonder what that was
15 before the rule

16 MR. DENNING: That's a good questions.

17 DR. BUELL: Are there any other questions
18 on that?

19 CHAIRMAN APOSTOLAKIS: No. Well, there
20 are many, but --

21 DR. BUELL: We just put this up there just
22 as an example --

23 CHAIRMAN APOSTOLAKIS: Little did you
24 know.

25 DR. BUELL: -- of what we could do with

1 the capabilities of SAPHIRE and these automation
2 techniques.

3 DR. BONACA: Now, just one last question.
4 If I look at these curves, I mean, and I had the
5 licensees here, would they agree to these results
6 generally?

7 DR. SCHROEDER: No.

8 DR. BONACA: They wouldn't.

9 CHAIRMAN APOSTOLAKIS: No.

10 DR. SCHROEDER: The licensee that has this
11 one takes great exception to that.

12 MR. DENNING: Where do you put it,
13 incidentally.

14 CHAIRMAN APOSTOLAKIS: On what basis?

15 MR. DENNING: I mean, what would his CDF
16 be for that? Do you know offhand?

17 DR. SCHROEDER: I don't remember the
18 details. Do you?

19 DR. BUELL: I don't know what the CDF is,
20 but the bottom line is that they take credit. They
21 have a unique surface water system. The only BWR with
22 that particular type of service water system, and
23 because of that vulnerability or because of that
24 design configuration, they're much more dependent on
25 other systems and they use some of these other systems

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 in ways that are not standard in the industry, and
2 until they give us information, in our estimation it's
3 very marginal use of it, and so until they get us
4 information that they can validate their use of that,
5 we're agreeing to disagree at this point and we're
6 saying until you can provide documentation that we're
7 satisfied with, we're not going to go there because
8 that is a non-standard application or a non-
9 standard --

10 CHAIRMAN APOSTOLAKIS: Which is what it
11 is.

12 DR. SCHROEDER: And the NRC SRAs for that
13 region have looked at the licensee's claims very
14 closely, and they have not given us a decision on what
15 they think ought to be done about the utility's
16 claims.

17 MR. CHEOK: For just a quick perspective,
18 we have been engaged with the licensee, and as Bob was
19 saying, they do have different processes that we are
20 not familiar with. We're asking for more
21 documentation from them, and after we review the
22 documentation and agree that it's feasible or the
23 recoveries, we will incorporate them, but at this
24 point we will have to wait to see what we will get.

25 MR. DENNING: But at this point it has

1 little relevance unless they come in with a risk
2 informed request for change or something like that?
3 Because the fact that it's one times ten to the minus
4 five that we say it is and they say it was something
5 else doesn't make any difference.

6 CHAIRMAN APOSTOLAKIS: No, but it makes a
7 difference because there are CDF --

8 MR. DENNING: But if you go with a risk
9 informed decision, then it could be a big --

10 DR. BUELL: It quickly comes to a head if
11 there's a finding or an issue related to these design
12 issues.

13 Next slide there.

14 Some more of the standardized structure.
15 Basically we've already hit this or identified this
16 before as small even tree, large fault tree, linked
17 methodology. We have a standard set of initiating
18 event candidates, and I'm not sure if all of these
19 make sense to you, but they're basically -- and I'll
20 go across the list -- it's a large LOCA, medium LOCA,
21 small LOCA, and excessive LOCA or a vessel rupture,
22 interfacing or intersystems LOCA, loss of off-site
23 power, loss of condenser heat sink, loss of main
24 feedwater, transient with PCS initially available.

25 And then we go into variance of the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 transient tree here, the loss of AC buses, the loss of
2 DC buses. Then we have loss of service water and loss
3 of instrument air.

4 That's pretty much our standard look, and
5 we had talked about before that this is the one
6 percent rule. If you look down here at the bottom if
7 we find a plant that has an initiator that doesn't fit
8 within this category, then we'll add that with this
9 one percent rule to make sure we cover the significant
10 portion of the plant risk.

11 Something that's boiling water, reactor
12 specific as an inadvertent open relief valve, and on
13 PWRs there's two type specific initiators there, the
14 steam generator tube rupture and the loss of component
15 cooling water.

16 So that's our standard set, and like I
17 say, we go beyond that if there's anything significant
18 showing up in it.

19 CHAIRMAN APOSTOLAKIS: What is LOCCW?

20 DR. BUELL: Loss of component cooling
21 water.

22 CHAIRMAN APOSTOLAKIS: That's a support
23 system, isn't it?

24 DR. BUELL: That is a support system.

25 CHAIRMAN APOSTOLAKIS: So you are

1 including some support systems.

2 DR. BUELL: We include many support
3 systems. The AC and DC buses, the service water, the
4 instrument air --

5 CHAIRMAN APOSTOLAKIS: Well what did you
6 say about support systems? They're not initiating
7 events?

8 DR. BUELL: We do not have fault trees.
9 There's two ways to generate a frequency or support
10 system initiator.

11 CHAIRMAN APOSTOLAKIS: Yeah.

12 DR. BUELL: You can either look at an
13 industry average and come up with a point value, or
14 you can build a fault tree based on a system unique
15 configuration that will generate a probability.
16 That's the difference.

17 CHAIRMAN APOSTOLAKIS: And why don't you
18 do it that way?

19 DR. BUELL: Well, we're going to get to
20 that shortly in one of these other slides, but number
21 one, there are some developmental issues and some
22 issues that haven't been completely researched yet,
23 and we're looking at that, but there are some down
24 sides of not having it in there, and we'll talk about
25 those in a few minutes.

1 CHAIRMAN APOSTOLAKIS: Okay.

2 DR. BUELL: Next slide, please.

3 Okay. Within the event trees, we have
4 front line system fault trees. Most of the fault
5 trees, the critical fault trees are based on systems
6 studies that were performed at the INL in years gone
7 by. That includes the reactor protective system, the
8 emergency power system, auxiliary feedwater, the high
9 pressure coolant injection, and the RCI system.

10 Some of the other front line fault trees
11 include or the modeling of those include active
12 components. That's an obvious inclusion in the
13 models, and the obvious or important operator actions,
14 and then we use a standard set of fault tree
15 guidelines to simplify those since there's a lot of
16 information that we don't have, detailed information
17 that we don't have, relay positioning and that type of
18 thing.

19 We made some simplifications on some of
20 the instrumentation information in our modeling. So
21 there are some ways to simplify these, yet still
22 retain the essence and the importance of these
23 components.

24 MR. DENNING: When we look at the
25 standardized system fault trees, for example,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 auxiliary feedwater or something like that, how many
2 different versions do you have to have of this system
3 fault tree to cover the spectrum of plants or are
4 they --

5 DR. BUELL: Well, I believe there was 11
6 different systems, okay, and as time goes on and we
7 need more and more detail and nuances, we modify those
8 somewhat. If we find there's another back-up
9 condensate source or another back-up long term cooling
10 source or whatever, we expand those models, but I
11 believe on AFW there were 11 system models originally,
12 and we have taken those and made them plant specific,
13 put the supports underneath them, plant specific
14 supports, and you know, plant specific valving and
15 that type of thing, but there's 11 basic
16 configurations for that.

17 And we've touched on the common cause
18 event modeling also, and some of the ways that we
19 apply common cause we have our own standard set of
20 rules that we look at. We don't typically put common
21 cause across multiple systems. All of the common
22 cause is within a given system. We have different
23 types of components that we give common cause
24 consideration to.

25 So we have, like I say, rules that allow

1 us to model these in a standard format.

2 The support system fault trees are the
3 ones that we just added in the last three or four
4 years. We're expanding the level of detail of those,
5 but some of the rules that go into those or some of
6 the modeling detail is we typically don't take power
7 all the way down to 480 volt, 120 volt, that type of
8 thing. We typically leave them at the divisional
9 level.

10 Now, as we need more and more detail,
11 that's not hard and fast. We are realizing in some
12 cases we have to add more detail to be able to get the
13 understanding of the plant, and we have been doing
14 that, but as a minimum we model it at the divisional
15 level.

16 MR. DENNING: Now, a typical utility would
17 go to a lower level, wouldn't it?

18 DR. BUELL: A typical utility would go to
19 a lower level. They'd go to a 180 volt level
20 typically, and like I say, we've been doing it more
21 often than not now because we need able to do that be
22 able to get the nuances of utilities model, but in the
23 past, and we don't have all of the models at that
24 level, but as we go in and look at them in the
25 detailed level, we've been adding much more AC and DC

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 power.

2 MR. DENNING: Okay.

3 CHAIRMAN APOSTOLAKIS: This is great
4 though that you're doing this. I mean, I was worried
5 the first time you said that we're not doing support
6 systems because it really --

7 DR. BUELL: No, we model support systems
8 in detail.

9 CHAIRMAN APOSTOLAKIS: They are so
10 important.

11 DR. BUELL: You bet.

12 CHAIRMAN APOSTOLAKIS: Okay, great. Now,
13 the next time we meet I would really like to
14 understand why you guys felt you needed to develop
15 SPAR-H and you did not use a female

16 MR. DENNING: Actually are you going to
17 talk about --

18 CHAIRMAN APOSTOLAKIS: Don't smile, don't
19 smile.

20 MR. DENNING: I know you mentioned. Are
21 we going to talk more about SPAR-H today? Because I'm
22 not going to be here in December, and I realize you're
23 going to get into it, but there's philosophical
24 questions about what we're trying to do with SPAR
25 versus what a utility might attempt to do with its PRA

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that could relate to this, and I wanted to get into
2 that.

3 DR. BUELL: Okay. Like I say, there's
4 going to be another meeting on that in December, and
5 I don't have the depth of knowledge to be able to
6 address philosophical concerns or whatever on SPAR-H.
7 I can tell you how we use it, how we apply it, but I
8 don't --

9 CHAIRMAN APOSTOLAKIS: Yeah, we'll do that
10 in December though.

11 MR. DENNING: I'm not going to be here in
12 December, but I do want to say something and that is
13 I'm going to be in Vienna. Isn't that great?

14 CHAIRMAN APOSTOLAKIS: Just send me an E-
15 mail. I'll say what you want to say. Go ahead.

16 MR. DENNING: And that is that I think
17 that there are different purposes for what the NRC is
18 really using their PRA for versus the things, the
19 breadth of things the utility can use its PRA for.

20 CHAIRMAN APOSTOLAKIS: Absolutely.

21 MR. DENNING: And that if you look at this
22 question like ATHENA, that a utility ought to be using
23 a really detailed HRA kind of approach because they
24 ought to be looking at that emergency operating
25 procedures and things like that, seeing what the

1 impact of those is on their rates.

2 CHAIRMAN APOSTOLAKIS: Well, they're not
3 using ATHENA though.

4 MR. DENNING: Well, no, but
5 philosophically the reason.

6 Now, here, we're not -- "we" being you
7 guys really -- you're not really going to the depth of
8 looking at specific emergency operating procedures.
9 You're coming up with -- and that really limits
10 obviously what you can do and what your objectives
11 are, and so I think that there's some objectives the
12 utility should have for its PRA that differ from your
13 objectives and that it doesn't make sense, you know,
14 for you to go to an extremely complex human
15 reliability model when, indeed, all you're going to be
16 doing is kind of looking at generic values across a
17 variety of plants rather than looking in detail at a
18 specific plant.

19 The same may be true of common cause.

20 CHAIRMAN APOSTOLAKIS: Yeah, but that's
21 where since they went to the alpha model there's no
22 excuse now. That means they can handle complexity
23 and --

24 MR. DENNING: But complexity is to some
25 extent plant specific complexity that they're not

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 going to get into, and I don't think that they have
2 to. I mean have to because of philosophically what
3 we're using SPAR for versus the variety of things that
4 I think that a utility can use its PRA for that --

5 CHAIRMAN APOSTOLAKIS: Two or three years
6 ago, Rich, the guys could develop a thing that came
7 before the full committee. A major piece of advice
8 they got was make sure you simplify so that people can
9 use it. Okay?

10 So the big question is now has that
11 happened, and do we have a de facto proof that it did
12 not happen.

13 MR. DENNING: Did not happen because of
14 SPAR-H.

15 CHAIRMAN APOSTOLAKIS: And we can put you
16 on a video from Vienna, by the way.

17 Can we go to 12?

18 DR. BUELL: Okay. Basically this is a
19 layout of our transient model for BWRs, which
20 everything is built on with the exception of the
21 LOCAs. It's a real quick run through there. We look
22 at reactivity control. We look at reactor system or
23 the coolant integrity, the SRBs, the open, stay open.
24 We look at some of the high pressure injection sources
25 if you don't have those. It's standard logic. You

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 depressurize. You go to low pressure systems, and we
2 have a variety of those as well as the VA, which is
3 some alternate systems, you know, some of the back-up,
4 the cross-ties, service water cross-ties and fire
5 water and all of the other ancillary type systems that
6 you can add.

7 We also have, as you are well aware, BWRs
8 are typically heat removal limited. That's what will
9 get you to core damage quicker than anything. So we
10 try to look at all the different aspects of heat
11 removal, and then finally we look at late injection,
12 and this has to do with long-term injection, and it
13 also has to look at potentially after containment
14 fails, and we'll talk about that in later slides.

15 CHAIRMAN APOSTOLAKIS: Excuse me. You are
16 starting now a relatively new topic, the assumptions,
17 and I suspect we're close to the break time. So why
18 don't we take a break now before you start talking
19 about assumptions?

20 DR. BUELL: Okay.

21 CHAIRMAN APOSTOLAKIS: And we should be
22 back around 10:30. That's the median.

23 Off the record.

24 (Whereupon, the foregoing matter went off
25 the record at 10:11 a.m. and went back on

1 the record at 10:32 a.m.)

2 CHAIRMAN APOSTOLAKIS: Okay. Let's go on.

3 DR. BUELL: George, can I say something
4 real quickly before we start?

5 CHAIRMAN APOSTOLAKIS: Sure.

6 DR. BUELL: We have 13 more slides on
7 standardized structure, and we go into a lot more
8 details into each one of those event frees. We were
9 just wondering if the committee wants to hear in
10 detail about all of those event frees or do we want to
11 just go ahead and finish the one event for Bs and one
12 for Ps and then maybe skip to the demo? It's up to
13 you all.

14 CHAIRMAN APOSTOLAKIS: I think that's a
15 good idea. The committee members agree?

16 MR. DENNING: If we're hurt for time, yes,
17 but otherwise --

18 CHAIRMAN APOSTOLAKIS: I think we probably
19 are. So your proposal, Mike is what?

20 MR. CHEOK: My proposal is that we will go
21 through the transient tree for the Bs and then one for
22 the Ps and the assumptions, the major assumptions for
23 the Bs and the Ps.

24 CHAIRMAN APOSTOLAKIS: Yes.

25 MR. CHEOK: And then perhaps we can go

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 through to the demo because later on I think we again
2 come back through the major assumptions for all the
3 models.

4 CHAIRMAN APOSTOLAKIS: Okay. So we are
5 skipping then the slides that Bob is preparing now, is
6 presenting now? Is that what you are --

7 MR. CHEOK: We will be probably going
8 through two or three more of these slides and then
9 skip about ten of them.

10 CHAIRMAN APOSTOLAKIS: Okay. That's a
11 good idea.

12 DR. BUELL: Okay. For the sake of time,
13 I'll skip even some of these bullets here.

14 On key BWR assumptions, event tree
15 assumptions, I'm just going to hit the last two.
16 Containment venting fails all injection. This is a
17 carryover from some of the early modeling, and like I
18 say, in a period of transition through a little more
19 detailed modeling. That's not acceptable anymore. So
20 what we're researching is putting some logic in there
21 that allows that to be tuned depending on the specific
22 plant.

23 Also the assumption that containment
24 failure causes a loss of all injection, that's going
25 to be coming up again in our top ten items, and I'll

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 discuss this further, but there's a lot of plants out
2 there that take credit for injection beyond
3 containment failure, and NUREG 1150 also did that, and
4 like I say, this is a transition issue, and I'll
5 explain that later in detail.

6 Next slide.

7 The general layout of a PWR transient
8 event tree, similar to the Bs we start out with the
9 reactivity issue. Then we look at the secondary
10 cooling through the steam generators with main
11 feedwater and AFW, and all of these acronyms, they're
12 all fault tree tops with detailed logic underneath
13 them.

14 So there's detailed logic underneath each
15 one of these tops here. Then we look at the reactor
16 coolant system integrity. Did the pores open or stick
17 open? And also, what's the status of the seals? And
18 so we check that for coolant system integrity.

19 We looked at the high pressure injection
20 and once through cooling, and then we look at
21 secondary site cool down and depressurization, and
22 finally containment heat removal, RHR and HPR. A
23 pretty standard structure, real similar to what you'll
24 see in standard PRAs.

25 So it's a --

1 MR. DENNING: If we looked at the event
2 trees, it's that simple, and then all of the logic is
3 down in the fault tree?

4 DR. BUELL: That's correct. If you'll
5 count those up, those are typically the number of
6 fault tree tops, you know, nodes across the top.

7 MR. DENNING: The event tree tops.

8 DR. BUELL: The event tree tops, across
9 the top of your event tree, and then each one of them
10 have a detailed fault tree underneath.

11 So some of the key assumptions here,
12 you'll see the two pour is required for feed and
13 bleed. This is an issue in about half of the plants
14 in the country. About half of them say we require two
15 pours. About half of them say we require one pour.

16 We globally require two pours, and there's
17 a variety of reasons for that, number one of which we
18 don't do detailed thermal hydraulics, and it appears
19 that a lot of the thermal hydraulics that were done
20 would lean towards the two pour of success criterion,
21 and we'll discuss that in more detail later on.

22 But like I say, if we have successful feed
23 and bleed, that gives us time to recover secondary
24 cooling then at some point in the future.

25 CHAIRMAN APOSTOLAKIS: How do you

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 determine the success criteria?

2 DR. BUELL: Well, we rely heavily on NUREG
3 1150 for success criteria. Like I say, because we
4 structure very similar to what they structure as far
5 as event tree logic. We rely heavily on NUREG 1150.

6 CHAIRMAN APOSTOLAKIS: And 1150, they
7 develop their own success criteria or they relied on
8 the vendors?

9 MR. DENNING: I would say it's their own.
10 I mean, I don't remember how much going back to
11 vendors there was.

12 CHAIRMAN APOSTOLAKIS: Yeah.

13 DR. BUELL: And typically most of the
14 equipment that are used in the success criteria is
15 real binary. I mean, you either have it or you don't
16 and there's only a few instances where you would
17 possibly need thermal hydraulics to ascertain whether
18 you could get by with something. So that's typically
19 not a real big deal.

20 Okay. What was our next slide?

21 DR. BONACA: Well, the question I have on
22 the PORV, I do believe that some PORVs you have to
23 show that they could, in fact, bleed. I mean, they
24 could stay open for a lengthy period of time.

25 And are the licensees typically dealing

1 with that issue there or --

2 DR. BUELL: Are you talking about long
3 term operations?

4 DR. BONACA: Yes.

5 DR. BUELL: The licensee, many of them
6 look at that. We look at it as far as battery
7 depletion. You know, when the batteries are gone,
8 then the pours are gone also if you're talking about
9 like a station blackout long term or if you lose air
10 in some instances long term.

11 DR. BONACA: So the licensees do make a
12 rational decision.

13 DR. BUELL: They do look at those issues
14 also.

15 Okay, and we're just going to skip all of
16 the rest of this. This is just some of the nuances
17 and details of how we look at some of the component
18 cooling water and such, some of the support system
19 initiated and how we model that.

20 John is going to give you a demonstration
21 of SAPHIRE now.

22 CHAIRMAN APOSTOLAKIS: Good.

23 DR. SCHROEDER: The SAPHIRE program is the
24 main engine for all of the SPAR models, and it's used
25 in conjunction with the GEM program, which are two

1 aspects of the same underlying calculation of
2 machinery. SAPHIRE is actually an acronym, and it
3 stands for something like safety analysis package for
4 hands-on integrated reliability evaluations. And GEM
5 is the graphical evaluation module.

6 And there's not much graphical about GEM.
7 I'll show you that, although the original design
8 vision was to make it sell.

9 Typical SAPHIRE model looks very much like
10 any other PRA model in that it has a bunch of risk
11 related objects. It has end states. It has
12 sequences, event trees, fault trees, and it has a lot
13 of basic events, and primarily it's a cut set solver,
14 but it also has some facilities to do off-line
15 calculations to come up with common cause failure
16 probabilities.

17 Off-site power recovery probabilities, de-
18 solar recovery probabilities, and it can do some sums
19 for -- you know, has utility options to come up with
20 fail to run probabilities that are like compound
21 curves, and I'll show you a little bit of that stuff.

22 When we start looking at a risk model, we
23 typically start with event trees, and this is a
24 typical list for a boiler. This is for the model that
25 you saw in advance, the pilgrim model. Some of these

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 are quite complicated.

2 The large LOCA is one of the simplest
3 event trees that we have. This is an example of it.
4 We would have an initiating event and then the front
5 line system questions or concerns. Then we would
6 resolve those into core damage end states, and in some
7 cases these can be transferred to other event trees
8 for further processing, and there are models for which
9 we do that.

10 What I'm in now is a simple graphical
11 editor. I can modify this. I mean, I can add
12 branches and the like. I can access some of the major
13 components of the model this way, for instance, the
14 pressure pool cooling model, and then with that I can
15 bring up the fault tree logic. I can modify the fault
16 tree logic. I can modify the basic events. All of
17 these are fairly common capabilities.

18 SAPHIRE has many user ease functions.
19 I'll get to some of the add in capabilities later, but
20 this is one that I think is fairly important to point
21 out. The SPAR-H method is actually built into
22 SAPHIRE. The design of SPAR-H was to provide
23 something that an analyst could use to make quick
24 assessments for the SDP or for ASP evaluations, and
25 the capability looks something like this.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 If we have a human related human action,
2 we would be able to specify whether there's a
3 diagnosis involved, and the event that I just happened
4 to pick does not have a diagnosis. It's a step down
5 the line in a procedure. The issue of whether the
6 right procedure has been selected has already been
7 determined. So it's basic. It's a basic action.

8 And what we would do is ask the user to
9 make judgments about the performance shaping factors
10 that apply, and they can do that by just entering in
11 values over here.

12 Now, as part of our attempt to do better
13 with uncertainty in the models, there is a capability
14 here to hedge your bets, to say that the experience
15 and training that's applicable to this event we
16 believe it is high with a high level of confidence,
17 but we could say that, well, maybe the analyst is only
18 90 percent certain that the experience and training is
19 high.

20 He might say that, well, maybe I feel ten
21 percent confident that it's only nominal, and you
22 would get an uncertainty distribution out of this
23 calculator appropriate to those inputs.

24 CHAIRMAN APOSTOLAKIS: So why don't you do
25 that so we can see?

1 DR. SCHROEDER: Okay. I'm not sure that
2 I can generate the uncertainty right here, but let's
3 put this in.

4 CHAIRMAN APOSTOLAKIS: Would five percent
5 low?

6 DR. SCHROEDER: Okay.

7 CHAIRMAN APOSTOLAKIS: Twenty percent
8 nominal, and let's see now. Twenty-five --

9 MR. DENNING: Let's make it 75 percent.

10 CHAIRMAN APOSTOLAKIS: No, I want things
11 sufficient, too.

12 MR. DENNING: It's automatic. You
13 can't --

14 CHAIRMAN APOSTOLAKIS: Seventy?

15 MR. DENNING: Oh, now, wait a second. Can
16 you do this?

17 CHAIRMAN APOSTOLAKIS: An insufficient
18 five.

19 DR. BUELL: As a default we typically --
20 since we don't have that level of knowledge, we put
21 100 percent in whatever our shaping factor is.

22 CHAIRMAN APOSTOLAKIS: Do they add up to
23 one now? Yeah.

24 DR. SCHROEDER: I think the module is
25 going to enforce it one way or another.

1 CHAIRMAN APOSTOLAKIS: Okay.

2 DR. SCHROEDER: Now, when an analyst does
3 this, the advice given is that it is not sufficient
4 just to throw in numbers. He ought to make notes on
5 why he specified those numbers and the code would
6 maintain these things.

7 And there's a possibility to do a
8 dependency calculation as well, although just
9 declaring the dependency here doesn't solve the
10 problem. I mean, you have to go into a SAPHIRE rules
11 capability and make sure that this dependent event is
12 applied in the right place in the cut set, and that's
13 something that takes a fair amount of training that's
14 not a trivial action.

15 But at any rate, this event didn't mode
16 any dependency on previous events.

17 CHAIRMAN APOSTOLAKIS: So what do we see
18 how? It's seven ten to the minus four?

19 DR. THADANI: Right.

20 CHAIRMAN APOSTOLAKIS: And it's not going
21 to show us the range?

22 DR. SCHROEDER: We can attempt to show the
23 range here, but I am not sure.

24 MR. DENNING: Well, what you might do is
25 if that's difficult is you could go through and change

1 those again and see what it does to the value.

2 DR. SCHROEDER: Right. The nominal value
3 is 5E minus four. When I distributed the degree of
4 belief here, I changed it to 7E minus four, and Curtis
5 Smith would be the person that would describe the
6 algorithm. I don't know that the algorithm for
7 distributing this is printed anywhere yet, whether
8 it's part of the SAPHIRE documentation or not. That
9 would have to come from the co-development people.

10 CHAIRMAN APOSTOLAKIS: But when we view
11 this in December, presumably we'll have access to
12 this, right? That's the whole point. Huh, Mike?

13 MR. CHEOK: I guess we can provide this
14 again in December if you would like.

15 CHAIRMAN APOSTOLAKIS: We have a report on
16 SPAR-H.

17 MR. CHEOK: That's correct.

18 CHAIRMAN APOSTOLAKIS: That report does
19 not explain these things?

20 MR. CHEOK: I don't believe it does
21 because this is a nuance of the SAPHIRE code, but we
22 can again bring this up.

23 CHAIRMAN APOSTOLAKIS: That's a key, you
24 know. And you can do this with all of the PSF showing
25 there, right? Complexity, available time, stress.

1 DR. SCHROEDER: And i can show that it
2 was.

3 CHAIRMAN APOSTOLAKIS: Okay, okay. So you
4 can't show us the uncertainty range right now, can
5 you?

6 DR. SCHROEDER: I believe so. Let's try.

7 CHAIRMAN APOSTOLAKIS: Let's try.

8 DR. SCHROEDER: I specify those factors.
9 The calculated probability now shows there, and
10 normally this event would be calculated with the
11 constrained noninformative, but if I go over here and
12 look at the uncertainty distribution, it looks like I
13 broke it.

14 Call Curtis.

15 CHAIRMAN APOSTOLAKIS: You broke it.

16 DR. SCHROEDER: When something like this
17 happens to a suer and it happens --

18 CHAIRMAN APOSTOLAKIS: He calls Curtis.

19 DR. SCHROEDER: -- we call Curtis, but
20 actually that's not the right answer. The right
21 answer is -- I mean, that's the real answer, but it's
22 not the right answer. The right answer is that all
23 SAPHIRE users have access to the SAPHIRE Web site, and
24 there is a trouble reporting system there, where
25 events like this are logged, and when you log into the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 SAPHIRE Web site, you register one of these
2 observations. then it goes into the SAPHIRE tracking
3 system, and the same process is now in place for the
4 SPAR models, by the way.

5 It goes into a tracking system where they
6 have to respond to this and fix it if they can. So
7 I'm going to restart that here.

8 CHAIRMAN APOSTOLAKIS: Maybe you needed to
9 put numbers on the other PSFs, too. Is that possible?

10 DR. BUELL: Well, I think typically we
11 don't use that function in our base models. We
12 default over -- we use a performance shaping factors,
13 but we default to 100 percent for each one of them,
14 but we typically don't have that level of knowledge of
15 understanding of the particular action.

16 CHAIRMAN APOSTOLAKIS: But this is one of
17 the more significant uncertainties, isn't it?

18 DR. SCHROEDER: In many ways, yes.

19 CHAIRMAN APOSTOLAKIS: Well, you had to go
20 all the way back there.

21 DR. SCHROEDER: I had to restart SAPHIRE.

22 CHAIRMAN APOSTOLAKIS: Yeah, okay.

23 DR. SCHROEDER: Because that was a fatal,
24 fatal error.

25 CHAIRMAN APOSTOLAKIS: I assume if the

1 operators don't know what they're doing, it's a fatal
2 error, right?

3 DR. SCHROEDER: Yeah.

4 CHAIRMAN APOSTOLAKIS: In more ways than
5 one.

6 DR. SCHROEDER: Okay. So I was sort of
7 showing the large loca event tree and walking down --

8 CHAIRMAN APOSTOLAKIS: Yeah, let's look at
9 that because --

10 DR. SCHROEDER: -- through many of the
11 capabilities.

12 CHAIRMAN APOSTOLAKIS: -- we discussed
13 that yesterday, too, didn't we, Rich? This is BWR.

14 DR. SCHROEDER: This is BWR.

15 MR. DENNING: Oh, you're wondering about
16 like no credit for contained over pressure.

17 CHAIRMAN APOSTOLAKIS: Yeah, is there any
18 place there where it asks whether the containment is
19 intact?

20 MR. DENNING: Well, the containment
21 venting gets relevant to that.

22 DR. SCHROEDER: It is implied. For
23 instance, if you have --

24 CHAIRMAN APOSTOLAKIS: No. You have to
25 have it before the core spray though, right?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. SCHROEDER: These are laid out more or
2 less in time order for the demand. For instance, you
3 would need to have core spray immediately, and then
4 some time very shortly after that demand, you would
5 need suppression full cooling, and if you had that,
6 you're basically find.

7 If the suppression cool cooling system is
8 unavailable, we would credit core spray -- well, in
9 this case it's containment spray. Excuse me --, and
10 since there's a fault tree linking going on here,
11 about the only way that you could fail this guy and
12 credit this guy is if the suppression pool cooling
13 discharge valves were failed because the other
14 components of the model are the same.

15 But then we come over here to containment
16 venting. We're out in time a fair ways now, and we're
17 trying to resolve the containment over pressure issue.
18 If containment venting is required because we don't
19 have any cooling and the containment is pressurizing,
20 we will question vent, and then we will question the
21 survival of any late injection.

22 Remember those.

23 MR. DENNING: That's kind of where it is
24 though because it's a question of weight injection.

25 CHAIRMAN APOSTOLAKIS: No, but I thought

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that the Loch Lepsiian (phonetic) core spray do depend
2 on whether you have a --

3 DR. SCHROEDER: But it's not their early
4 performance. They perform Okay early. It's late then
5 that they would fail.

6 CHAIRMAN APOSTOLAKIS: Or you could have
7 it the other way. They put the NR system. They put
8 the IP up front and they say if you have significant
9 leakage, then you don't get the right NPSH.

10 MR. DENNING: That's right.

11 CHAIRMAN APOSTOLAKIS: So it's relevant
12 both places, isn't it? That's what I saw.

13 MR. DENNING: No, but actually the failure
14 in cooling occurs late. Even though it's preexisting,
15 leakage from the containment that could cause -- I
16 mean obviously it's not included in this event tree.

17 CHAIRMAN APOSTOLAKIS: The Web site of the
18 NRC under GSI 193, for a fast, large LOCA, the LPSI
19 and CS pumps fail within seconds if you don't have
20 sufficient NPSA. So you don't even reach the lab.

21 MR. DENNING: They have sufficient NPSH
22 early. It's late when they heat up the pool. You
23 know, in this case we were looking at yesterday, you
24 know, we don't want to get into this in any detail,
25 but it's not -- that mode of failure isn't shown on

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 there, but that I think is because every plant is
2 taking credit for the NPSH being there and --

3 CHAIRMAN APOSTOLAKIS: Yeah, this does,
4 too, right? This event tree?

5 MR. DENNING: Yes, this absolutely does,
6 but in their PRAs they don't take into account the
7 exercise which --

8 CHAIRMAN APOSTOLAKIS: But if I wanted to
9 take into account, I would modify this because John
10 told us you can do that. You can go back and change
11 the branches and all of that, but right now it assumes
12 that you have sufficient NPSH.

13 MR. DENNING: And obviously the things
14 that we saw that Marty presented yesterday, he must
15 have done that, right?

16 CHAIRMAN APOSTOLAKIS: He used SPAR.
17 That's what he says. so he modified the three.

18 Okay. Let's keep going then and look at
19 the probability again.

20 DR. SCHROEDER: You want to look at the
21 probability calculations again?

22 CHAIRMAN APOSTOLAKIS: Yeah, just one
23 example.

24 DR. SCHROEDER: Okay. Let's access it
25 from a different place in the code. Typically when we

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 deal with basic events, we come over here and bring up
2 the basic event list, and a typical basic event is
3 identified with nomenclature that comes from a NUREG.
4 It's a fairly old NUREG, but at least it's some
5 reference that can establish uniformity in the models.

6 In this particular basic event I have an
7 AC power distribution system, and I have an AC bus,
8 and I have a low power or no power failure mode, and
9 a key detail in all of this is that this is a plant
10 specific event, but it uses a generic event in its
11 quantification. We link it to something called a
12 template.

13 In this case the template is the AC bus
14 component template. That defines the failure rates
15 the mission time and the uncertainty parameter for
16 that particular system, component, and failure mode,
17 and there's an entire library of these things in every
18 model. Part of our ability to use automation depends
19 on this standard library of templates, and those would
20 be visible at the end of a model.

21 They start with Zs. This is the template
22 library, and it is anticipate that there will be a
23 NUREG that describes how these failure rates and
24 probabilities were determined because all of them have
25 associated parameter uncertainties.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: So if we go to the
2 human error matter we tried to do before?

3 DR. SCHROEDER: Well, we can go back to
4 that one. Let's see. Which one did I -- RHR/SPC.
5 Let's see. I think that was the one we tried to deal
6 with.

7 CHAIRMAN APOSTOLAKIS: Okay, yeah. Five
8 times ten to the minus four, yeah.

9 DR. SCHROEDER: That was the nominal. I
10 didn't save the calculation when it crashed.

11 CHAIRMAN APOSTOLAKIS: Okay.

12 DR. SCHROEDER: I'd hate to attempt to go
13 into this one again because if there's some error in
14 this model, we could just fumble around with that for
15 some time. I could try to default here, but --

16 CHAIRMAN APOSTOLAKIS: Is it possible that
17 you have to go to the edit there? No, down. Yeah,
18 that edit.

19 DR. SCHROEDER: If you want to go to the
20 human factor calculator, you can go back to it.

21 CHAIRMAN APOSTOLAKIS: Yeah, okay.

22 DR. SCHROEDER: And is there anything else
23 here you'd like to see?

24 CHAIRMAN APOSTOLAKIS: Well, if we try to
25 do what we attempted earlier.

1 DR. SCHROEDER: Okay.

2 MR. DENNING: Let's not do it the same
3 way.

4 CHAIRMAN APOSTOLAKIS: Let's go to
5 available time and see what it says. Okay. So let's
6 put just enough, 20 percent, and nominal 60, and extra
7 time, well, that's a difference, but 20, and see what
8 happens now.

9 DR. SCHROEDER: Okay. We had change in
10 the value.

11 CHAIRMAN APOSTOLAKIS: It went up.

12 DR. SCHROEDER: And I fear that if we try
13 to go to the quick and dirty uncertainty --

14 CHAIRMAN APOSTOLAKIS: No, there.

15 DR. SCHROEDER: We got one this time.

16 CHAIRMAN APOSTOLAKIS: We got one.

17 DR. SCHROEDER: Okay.

18 CHAIRMAN APOSTOLAKIS: So the 95th
19 percentile is 5.28 ten to the minus three, and the
20 fifth is ten to the minus six. So there is a
21 significant, three orders of magnitude, range.

22 Yeah, we certainly have to look at how
23 these things are determined, Niles. At least you get
24 some results.

25 Has there been any coordination here with

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the guys who are developing ATHENA?

2 MR. CHEOK: We have talked to them once in
3 a while to see where they are and what we're doing.

4 CHAIRMAN APOSTOLAKIS: But they have not
5 reviewed this in detail.

6 MR. CHEOK: Oh, they have reviewed them.
7 We have provided the SPAR-H NUREG to them, and all the
8 authors of ATHENA have given its comments and they
9 have been incorporated.

10 CHAIRMAN APOSTOLAKIS: Okay. So anyway,
11 for December it would be nice to address these
12 questions. Okay.

13 DR. SCHROEDER: One of the other features
14 of SAPHIRE that we rely on heavily, this is all
15 related to the compound event. The HRA add-in is sort
16 of an aspect of this compound event calculation,
17 although that was a special case. The more general
18 case when you declare a compound event, we come over
19 here to this compound event tab, and what we look for
20 is a series of libraries.

21 These are all special code capabilities
22 that aren't necessarily needed by the general
23 population of users, but have been developed for one
24 special user or another. The SPAR model development
25 program uses this common cause failure calculation.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 It uses the plug utility calculation. It uses this
2 four group LOOP DOL and then there's another LOOP
3 recovery DOL that are used to calculate various
4 quantities used in the SPAR program.

5 This particular event that I brought up is
6 a common cause failure calculation. Other events that
7 are very important are these off-site power recovery
8 events. Again, we use the compound event to calculate
9 those, and the inputs to the calculation would be the
10 frequencies of each loss of off-site power category,
11 the plant center, the grid, the switch yard, et
12 cetera, and the medians for the assumed distribution,
13 and the error factors for the distribution.

14 This will allow SAPHIRE, when it does its
15 Monte Carlo solution to, in effect, calculate the
16 recovery probability from a different trial or
17 different curb definition. There's a family of
18 recovery curves for each of these, and I can talk
19 about that a little bit more when you go to our
20 uncertainty calculations.

21 But the reason that we went to the DOL on
22 this is that in any given SPAR model, they will
23 probably use at least half a dozen of these events,
24 and for event evaluation, it is frequently necessary
25 to recalculate those for a class of loss of off-site

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 power initiator.

2 The GEM module makes that happen without
3 the user having to recalculate anything and enter new
4 values. I will demonstrate that in a little bit.

5 Okay. So we have event trees, and we have
6 fault trees and basic events. Let me show you a
7 fairly complex event tree just to show you the range
8 in size. The TRAN event tree will be hard to see
9 here, but this is probably as large an event tree as
10 there is in the SPAR program, and in fact, this event
11 tree is much larger than you see here because these
12 represent transfers for other aspects of the model.

13 For instance, this is another event tree
14 for a stuck open -- you see in the text that describes
15 that here. It's more legible down here. This is for
16 one stuck open relief valve. This is for two stuck
17 open relief valves, and this is ATWS. Those are
18 really all technically part of this event tree, except
19 those are reusable pieces that other event trees
20 reference as well.

21 Now, in the SAPHIRE paradigm, you need to
22 link those event trees to create sequences. So what
23 we are looking at is really no more than a graphic,
24 and when SAPHIRE creates the sequences, it stores them
25 at a different place. You will come over here, and we

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 can select sequences, and then we can look at our
2 results through the sequences. This is what SAPHIRE
3 solves to give us a core damage frequency.

4 And we have many editing capabilities
5 within the SPAR model. We can display the cut sets
6 for all of the sequences or groups of sequences, and
7 this is a typical result, cut set list for the overall
8 model. We can slice and dice this. There's a
9 capability to collect cut sets. Say if I wanted to
10 look at loss of off-site power cut sets that have a
11 core spray check valve failure in them. I can apply
12 that, and if there's anything that meet that criteria
13 -- in this case there was nothing that met the
14 criteria -- I could do that.

15 Something that would definitely be here
16 would be like EPS failures, emergency power system
17 failures. If we had a failure of the diesel to run,
18 we could add that, and we'd probably get quite a few
19 of those, and we can reference the full list, what's
20 included in our particular slice of the result, and we
21 can see what's excluded from the slice.

22 And more to the point, we can save this in
23 an end state for later review and for additional
24 sliding.

25 CHAIRMAN APOSTOLAKIS: And these are run

1 according to the frequency?

2 DR. SCHROEDER: yes.

3 CHAIRMAN APOSTOLAKIS: But, my goodness,
4 look at that. All of them are very low.

5 DR. SCHROEDER: Well, I picked cut sets
6 with a very particular criteria. You had to have a
7 LOOP initiator and failure of just DGA. There are
8 only 500 of these cut sets in the model, and if we
9 were to look at how many cut sets are in the model,
10 this particular model has 10,000 cut sets in it at
11 this truncation level.

12 CHAIRMAN APOSTOLAKIS: Can we for this
13 system now look at the CDF?

14 DR. SCHROEDER: We can look at the CDF for
15 any system, but we have to --

16 CHAIRMAN APOSTOLAKIS: And for the whole
17 plant, can we look at the system?

18 DR. SCHROEDER: Yes.

19 CHAIRMAN APOSTOLAKIS: Yeah, let's look at
20 that.

21 DR. SCHROEDER: We were looking at CDF for
22 the whole plant. That was what I was showing you.
23 There's more than one way to look at it. For
24 instance, if we want to look at the CDF sequence by
25 sequence and get the overall result, here is the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 total, and here is how it breaks down by sequence.

2 In SAPHIRE the sequence specified by a
3 sequence number and the event tree name, and we use
4 very standard abbreviations so that a person that has
5 used the SPAR model for a little while would just
6 glance at this list and automatically recognize that
7 we had an inadvertent open relief valve or we have a
8 large LOCA or a transient or a loss of condenser heat
9 sink.

10 That's part of the advantage of
11 standardization.

12 Now, the SAPHIRE environment that I've
13 been demonstrating here is the main tool of the model
14 developers. It's the main tool to maintain models,
15 and it's the tool that you need if you're going to do
16 a very detailed analysis.

17 But for most routine analyses, we try to
18 make life easier for the user. We go to the GEM
19 framework, and I went to the GEM environment here, but
20 there's something else I want to point out. In all of
21 the SPAR models we have this disclaimer, and there has
22 been an issue with people grabbing a model and trying
23 to use it without really understanding what the major
24 issues associated with the use of that model were.

25 So in an attempt to mitigate against that,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 we've provided a screen that says, well, I know all
2 about the limitations of this model and I'm ready to
3 go on, and if I don't know all about them, I'm really
4 supposed to come over here and look at them.

5 And there would be a summary like this
6 that's plant specific for each model that says, well,
7 you know, this is the number one hitter for us on this
8 model. We really have an impact here that needs to be
9 represented or accounted for or considered in our
10 analysis, and these impacts are in ones, twos, and
11 threes. Well, what do they mean?

12 This is what a one, two, or three means in
13 the impact. An evaluation of this kind exists for all
14 of the models, and it is the major part of our attempt
15 to deal with structural uncertainties in the model.

16 CHAIRMAN APOSTOLAKIS: So this is the
17 impact of the whole sequence there. Well, it's
18 actually groups of sequences, right?

19 DR. SCHROEDER: This summary over here is
20 based on the total impact of core damage frequency on
21 the whole model.

22 Okay. So if I've looked at this and
23 decided that I understand them, then I can go on and
24 do my analysis. One of the key facilities in the
25 initiating event assessment capability here, and the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 reason that that's important is because we get the
2 substitutions for our class of loss of off-site power.

3 I need to declare one, and it might be
4 something like a PC, plant centered, loss of off-site
5 power, and I know that it's a loop initiator. I have
6 a list here. This is special. The other initiators
7 wouldn't ask this question, but I have an opportunity
8 to tell the module what kind of loss of off-site power
9 event I am dealing with, and if I select plant
10 centered, I'm going to get a bunch of automated
11 calculations.

12 The first thing it does is it goes through
13 and sets all of my initiating event frequencies to
14 zero and the LOOP frequency to one or true and false,
15 as the case may be. And then it goes out and it
16 recalculates all of my off-site power recoveries.

17 Now, GEM doesn't know which of these are
18 used. It just goes and calculates all of them, and
19 some of them will be hanging around and unused, but it
20 will recalculate the ones that are needed.

21 CHAIRMAN APOSTOLAKIS: There is a detail
22 there hour by hour of the recovery.

23 DR. SCHROEDER: Yes.

24 CHAIRMAN APOSTOLAKIS: How is that used?

25 DR. SCHROEDER: Well, I can show you that,

1 although it would be best not to show it in the GEM
2 environment. I need to switch back. So let me do
3 that. Let me cancel this process.

4 CHAIRMAN APOSTOLAKIS: I mean the result
5 should be an integral value, right?

6 DR. SCHROEDER: Yes.

7 DR. BUELL: We put a full set of those
8 hour by hour for 24 hours even though we don't use
9 them all. It's just part of the library of events
10 that we put in there. So that's standard for every
11 model. We'll have every hour in there.

12 DR. SCHROEDER: Switch back to SAPPHIRE
13 again.

14 CHAIRMAN APOSTOLAKIS: But in a particular
15 situation, you may have a thermal hydraulic
16 calculation that says, you know, in 45 minutes you're
17 going to be in trouble. Then you will go and pick the
18 appropriate value for recovery of power.

19 DR. BUELL: Exactly.

20 CHAIRMAN APOSTOLAKIS: I see.

21 DR. SCHROEDER: This is how it works.
22 this is the station blackout model for this plant.

23 CHAIRMAN APOSTOLAKIS: Yeah, yeah. Okay.

24 DR. SCHROEDER: And many of the things
25 that we have to talk about today involve what the

1 right time is to credit in this column. For this
2 particular model, if we have a HPCI or RCCI success
3 and we're able to depressurize at some point down the
4 line and bring on fire water and extend our battery
5 lifetime sufficiently by accredited load shedding
6 procedures at the plant, we would have a 14-hour
7 limitation --

8 CHAIRMAN APOSTOLAKIS: Okay.

9 DR. SCHROEDER: -- recovery for the
10 sequence.

11 In another sequence, we --

12 CHAIRMAN APOSTOLAKIS: So the quote then
13 would be peak just --

14 DR. SCHROEDER: Well, that's already coded
15 in the fault tree, and what the code needs to do, it's
16 automated. See, the model developer has to do all of
17 this.

18 CHAIRMAN APOSTOLAKIS: Right, but --

19 DR. SCHROEDER: There are basic events in
20 there for each, and if we look at one of the
21 graphics --

22 CHAIRMAN APOSTOLAKIS: But from the series
23 of values you showed us, only the value corresponding
24 to that time would be selected.

25 DR. SCHROEDER: Right.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Okay, okay.

2 DR. SCHROEDER: In this particular
3 sequence that I just selected the fault tree for, this
4 would be the default, the smallest value in the model.
5 All of the others are bigger than this. I could
6 credit off-site power recovery in 30 minutes. I could
7 credit the operator failure to recover a diesel in
8 that 30 minutes, and then there's some credit for
9 ability to align off-site or optional power supplies.

10 There's a blackout generator at this
11 plant. There is another off-site line that they want
12 to take credit for, and because this is a 30-minute
13 sequence, there are probably operator actions in these
14 that are more restrictive than the general case here.

15 At any rate, the calculation that GEM is
16 going to do for you is going to change this number
17 depending on what class of loop you had. For
18 instance, if this was a grid related analysis that I
19 was doing, this would be a very different number than
20 if it was a weather related analysis that I was doing.

21 CHAIRMAN APOSTOLAKIS: Sure.

22 DR. SCHROEDER: And because that's
23 difficult to calculate, GEM does it. In fact, SAPHIRE
24 does it for the base case by doing a frequency
25 weighted average of the loop classes.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: If I change
2 something, how long will it take for the model to
3 recalculate overloads?

4 DR. SCHROEDER: Not very long. I could
5 generate this one here. I started to do that PC LOOP.
6 We could look at this change set. What I was doing in
7 GEM is reflected in SAPHIRE, and if I start to run
8 this, I would get a result based upon just a nominal
9 loss of off-site power.

10 And because loss of off-site power is a
11 fairly complicated thing, I might want to change the
12 truncation for that when I go to run it.

13 SAPHIRE is now making the values that I
14 selected the temporary values to use in the
15 calculation. If I come over here to the sequences,
16 select all of the sequences and ask the code to solve
17 it, I don't want to attempt to solve this model at D
18 minus 12 anymore because I've changed the initiating
19 event frequency by three orders of magnitude.

20 On a desktop engine, it might be
21 reasonable to solve it here, but just for the sake of
22 a demonstration, let me knock that back to -- I was
23 trying to go for ten there -- and see how long it
24 takes.

25 It's not working the problem, and each

1 time you see a flash down here, it's finishing up a
2 sequence.

3 CHAIRMAN APOSTOLAKIS: Gez.

4 DR. SCHROEDER: And it's done. So if I
5 wanted to see the results associated with that
6 analysis, and I can sort them by the --

7 CHAIRMAN APOSTOLAKIS: I want to see the
8 total. Can we look at the total CDF?

9 DR. SCHROEDER: Yes. That is there.

10 CHAIRMAN APOSTOLAKIS: So it was done in
11 15 seconds, right?

12 DR. SCHROEDER: Yeah, and this is the
13 result.

14 CHAIRMAN APOSTOLAKIS: So the total CDF is
15 -- and if I want to look at the uncertainty on that?

16 DR. SCHROEDER: If I want to look at the
17 uncertainty on that, I'll have to write an additional
18 calculation. I'll have to go to uncertainty, and I
19 could probably run 5,000 samples fairly quickly.

20 CHAIRMAN APOSTOLAKIS: Okay.

21 DR. SCHROEDER: But so that we're not here
22 too long, I'll try it with 1,000, and down here you
23 have the running sample count.

24 CHAIRMAN APOSTOLAKIS: This is straight
25 Monte Carlo.

1 DR. SCHROEDER: I believe that's what I
2 selected. The LSH option is available. Those are the
3 only two options.

4 MR. DENNING: Now, what did it do before?
5 It did a point estimate before?

6 DR. SCHROEDER: That was just a point
7 estimate, and doing this sort of by sequence here, the
8 project.

9 CHAIRMAN APOSTOLAKIS: It probably takes
10 a minute or so. It did it?

11 DR. SCHROEDER: So now I want to
12 display --

13 CHAIRMAN APOSTOLAKIS: No, the previous
14 one, the uncertainty, yeah.

15 DR. SCHROEDER: Yeah, display uncertainty?

16 CHAIRMAN APOSTOLAKIS: Yeah.

17 DR. SCHROEDER: This is the result I have
18 now.

19 CHAIRMAN APOSTOLAKIS: Now, in the
20 previous one you had things like -- yeah, here, the
21 cyrtosis, skewness. You are obviously working with
22 statisticians.

23 (Laughter.)

24 DR. SCHROEDER: Right, although for
25 someone who is not a statistician, we have current

1 quantile display and we have a plot, and the plot is
2 based on a fairly limited number of data points. In
3 other words --

4 CHAIRMAN APOSTOLAKIS: Maybe we should
5 have Regulatory Guide 1174 that uses the mean CDF and
6 its cyrtosis.

7 (Laughter.)

8 CHAIRMAN APOSTOLAKIS: Huh?

9 MR. CHEOK: No comment.

10 CHAIRMAN APOSTOLAKIS: No comment.

11 PARTICIPANT: I thought that had to do
12 with the Atkins diet.

13 (Laughter.)

14 CHAIRMAN APOSTOLAKIS: Great, John. This
15 is very good. This is very, very good.

16 DR. SCHROEDER: There's one thing that I
17 really wanted to show you in GEM, and to show it I
18 really need to get to the back end of the calculation
19 because I think it's an important feature. So let's
20 try to go and do a real quick assessment here without
21 changing anything.

22 And I'm going to change the cutoff even
23 lower here. So it won't be a very meaningful
24 calculation, but it will be fast.

25 CHAIRMAN APOSTOLAKIS: Now, you have done

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 sensitivity studies to appreciate the significance of
2 the cutoff value?

3 DR. SCHROEDER: Yes, yes, and we maybe
4 don't do a sensitivity study on each plant each time
5 because we make a judgment that E minus 12 is deep
6 enough for all of the models, and generally it is more
7 than deep enough.

8 And since the code only takes a minute or
9 two to solve, if a person wants to knock that down to
10 E minus 15, they can. In fact, when I benchmark a
11 model, I often have to go to E minus 15 to make sure
12 that very low importance events show up in the cut
13 set. We don't ship it that way, but you know, it's a
14 five minute calculation at my desk.

15 Now, the reason I wanted to show you
16 this --

17 CHAIRMAN APOSTOLAKIS: So you take a
18 break?

19 DR. SCHROEDER: Pardon me?

20 CHAIRMAN APOSTOLAKIS: During those five
21 minutes you take a break?

22 DR. SCHROEDER: Yes. Get some more
23 coffee.

24 I have a solution here from that
25 calculation. These are the sequences that survive my

1 very high truncation. There's not much there.

2 But I wanted to show you the reporting
3 function, and it's fairly crude, but it's important
4 because the idea in creating GEM was to have something
5 that produced a quick report that totally documented
6 the result.

7 In this case I had a conditional core
8 damage probability which is the metric for initiating
9 event assessments, a 3.5 E minus 6, but if I printed
10 this thing off and stuck it in a binder someplace and
11 somebody asked me how I got that result later, well,
12 the model would have all of the details necessary or
13 the report would have all of the details necessary.

14 For instance, I have the probabilities
15 that the original base case had and then the current
16 case has. The current case is namely my analysis
17 circumstances. I have the initiating event value and
18 then all of the recovery values, and if I had changed
19 any other components in here, those would show up in
20 the list.

21 Then I summarized the sequences in the
22 conditional core damage frequency of each sequence
23 that contributes to my result. Then I go and I tell
24 the reviewer what the definition of the sequence is in
25 terms of systems.

1 For instance, loss of off-site power,
2 sequences 32-9 would actually be a blackout sequence,
3 and a person would need to go and look at the station
4 blackout event tree to understand that quickly, but if
5 they didn't go to the event tree, they can see the
6 sequence logic. There was a success of the reactor
7 protection system with the failure of emergency power
8 with a stuck open relief valve, with failure of the
9 RCCI system and failure of the HPCI system.

10 And because I know what those
11 abbreviations are, I didn't have to come down here and
12 read it, but if I needed to know what the systems
13 were, I would come down here and find out in my fault
14 tree list.

15 This is just the fault trees that were
16 actually used in any of the sequences that showed up
17 in the results.

18 CHAIRMAN APOSTOLAKIS: Very good.

19 DR. SCHROEDER: Then I would come down and
20 I would look at the cut sets associated with each
21 sequence, and when I get all done with that I --

22 CHAIRMAN APOSTOLAKIS: Do you have an
23 importance measure someplace?

24 DR. SCHROEDER: Not here, but that's
25 because I didn't ask for that. I can go back and I

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 can request those.

2 CHAIRMAN APOSTOLAKIS: No, that's fine.

3 By the way, I remember you're calculating
4 Fussell Vesely, right? No, actually you call it
5 something else.

6 DR. SCHROEDER: We calculate almost
7 anything that anybody has thought of that they might
8 want to see in the model.

9 CHAIRMAN APOSTOLAKIS: No, but you call it
10 something else. You call it risk reduction work,
11 right? At least in the earlier versions it was a risk
12 reduction work. It still is.

13 DR. SCHROEDER: They get the same results,
14 yes.

15 CHAIRMAN APOSTOLAKIS: Except you do some
16 calculation, right?

17 DR. SCHROEDER: That's right.

18 CHAIRMAN APOSTOLAKIS: The fossil vessel.

19 DR. SCHROEDER: At any rate, if I go
20 back --

21 CHAIRMAN APOSTOLAKIS: Now, since you've
22 done all of these things, do you have a plot of the
23 CDFs of all these reactors?

24 DR. SCHROEDER: I don't have one right --

25 CHAIRMAN APOSTOLAKIS: A base case?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. SCHROEDER: I don't have such a thing
2 ready to hand out, but in effect, it can be generated
3 rather quickly using the automation that we talked
4 about earlier. It's just that we don't keep such a
5 thing ready to hand out. We would have to go back to
6 our desk and run the macro, and it would probably come
7 out in 15, 20 minutes once it --

8 CHAIRMAN APOSTOLAKIS: I mean, if you get
9 like the one you showed for the station blackout.

10 DR. BUELL: We could run that, and we have
11 some automatic macros that will dump that out into a
12 report function and --

13 CHAIRMAN APOSTOLAKIS: Okay. You can run
14 it. Have you run it before?

15 DR. BUELL: At various times we've looked
16 at that.

17 CHAIRMAN APOSTOLAKIS: And what was the
18 conclusion? I mean, are there any CDFs that are close
19 to ten to the minus four or higher?

20 DR. BUELL: There was a couple of them,
21 but we've since knocked them down. There's none above
22 ten to the minus four at this point.

23 CHAIRMAN APOSTOLAKIS: None?

24 DR. BUELL: There are some that are close,
25 but there's none above ten to the minus four at this

1 point.

2 DR. SCHROEDER: There was one plant that
3 showed up right at the line, and they took great
4 exception to that and have been arguing with us about
5 it since, and pending resolution by the SRAs on what
6 to credit at that plant, it could be substantially
7 lower than that.

8 CHAIRMAN APOSTOLAKIS: Well, that's
9 significantly different from the conclusions of the
10 IPE project, right?

11 DR. BUELL: Well, there's been a lot of
12 pencil sharpening in the intervening years.

13 CHAIRMAN APOSTOLAKIS: That was my
14 question. Is it because of pencil sharpening or they
15 actually did something? But this is not for you. I
16 mean, somehow we will ask this question of somebody
17 else. Nilesh, is that you? Is it your group?

18 MR. CHEOK: My guess is it's both. I
19 mean, plants have done improvements since the IPEs,
20 and they've done improvements as part of the IPEs, but
21 there's also improvements in technology and how we
22 define things, and that has brought down the CDF.

23 CHAIRMAN APOSTOLAKIS: So is it fair to
24 say, Mike, there are no units in the United States
25 that are above the goal for internal events at power?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. CHEOK: It's probably fair to say that
2 SPAR models at this point do not show too many units
3 or any units that are above the goal for internal
4 events, but that's for the scope of SPAR models.

5 DR. THADANI: George, why is there ten to
6 the minus four? A reactor year core damage frequency
7 goal for internal events?

8 CHAIRMAN APOSTOLAKIS: No. This is the
9 total

10 DR. THADANI: That's what I thought. So
11 internal events would be some --

12 CHAIRMAN APOSTOLAKIS: Yeah, but we're
13 calculating internal events only.

14 DR. THADANI: And to answer your earlier
15 question, you might recall that there was a NUREG
16 prepared that provides insight scan from IPE reviews
17 and IPEEE reviews, and that describes briefly some of
18 the things that the licensees have done.

19 CHAIRMAN APOSTOLAKIS: There were 19 PWR
20 units whose CDF was above the goal.

21 DR. THADANI: Yes.

22 CHAIRMAN APOSTOLAKIS: So if now there's
23 only one and even that is in doubt, that's a
24 significant change, it seems to me. Somebody should
25 come here and brief the committee about that. Is it

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 a former IPE guys or somebody, or maybe you? Give us
2 a profile from what you've got from a CDF.

3 MR. CHOKSHI: I think whoever does it will
4 have to study it. We'll have to study and look at all
5 of these pieces and --

6 CHAIRMAN APOSTOLAKIS: Take your time.
7 Take your time. So tomorrow at noon, you'll probably
8 do it.

9 (Laughter.)

10 CHAIRMAN APOSTOLAKIS: No, it's really an
11 important insight because the committee, not just the
12 subcommittee, the committee has been left with the
13 impression that was created by the IPEs. I mean their
14 report that Mr. Thadani just mentioned, and if now we
15 have a change, it would be nice to know that, right?
16 Because the IPEs didn't look at the low power shutdown
17 either.

18 DR. THADANI: No, they did not.

19 DR. BUELL: There have been many plant
20 mods in the intervening years. There's been a lot
21 of --

22 CHAIRMAN APOSTOLAKIS: I appreciate that.

23 DR. BUELL: And even recently we just
24 receive updates of plant mods.

25 CHAIRMAN APOSTOLAKIS: When NUREG 1150

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 came out and it was reviewed, that was one of the
2 issues that was addressed. How are the results of
3 NUREG 1150 different from those of the reactor safety
4 study? And there was a significant reduction in all
5 of the metrics, and that was a very nice thing to see.

6 And, again, it was really a combination of
7 both better analytical methods and plant --

8 MR. CHEOK: And plant experience,
9 operating experience. We show in our trending
10 analysis that component reliabilities are going up and
11 initiating frequencies are coming down.

12 CHAIRMAN APOSTOLAKIS: So you produced a
13 report that made that very clear.

14 MR. CHEOK: That's correct.

15 CHAIRMAN APOSTOLAKIS: But it seems to me
16 that kind of information would be useful to the
17 Commissioners as well. I mean, this gives a picture
18 of the industry, right? This is where we are now.

19 MR. DENNING: But Dana is going to say,
20 "Well, what's the seismic risk then?"

21 CHAIRMAN APOSTOLAKIS: Dana is not here.
22 So he cannot say it.

23 MR. DENNING: No, I agree.

24 CHAIRMAN APOSTOLAKIS: No, but really,
25 it's nice to see every several years that we are

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 improving this. I mean, there was a very impressive
2 result and figures were produced comparing 1150 with
3 reactor safety study. Very impressive.

4 MR. DENNING: But it is as part of that
5 important to say, "Well what has the plant actually
6 done?" It has reduced it --

7 CHAIRMAN APOSTOLAKIS: Absolutely.

8 MR. DENNING: -- versus how much as
9 sharpening your pencil.

10 CHAIRMAN APOSTOLAKIS: You have to
11 understand that. So maybe, Niles, it's your group
12 that will have to do this at some future time because
13 you guys have access to all this, and all you have to
14 do is go back to the IPE lessons learned, and they
15 have a couple of tables. I mean, it's not a big deal.

16 MR. CHOKSHI: Well, also we're to look at
17 this is plant journey analysis (phonetic). What are
18 the features? Both sides you need to look at
19 carefully and see.

20 CHAIRMAN APOSTOLAKIS: Yeah, yeah. See
21 there is no other side. I don't think the IPE group
22 exists anymore.

23 MR. CHOKSHI: Charlie's group will take it
24 under advisement.

25 CHAIRMAN APOSTOLAKIS: Typical staff

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 response. "We'll think about it," which is okay. We
2 really want you to think about it before you come
3 here.

4 No, but I think that's important. It may
5 even be worth issuing a report on that, a small --

6 MR. CHOKSHI: Well, I think it's very
7 interesting as you said, a question inside that you
8 can get.

9 CHAIRMAN APOSTOLAKIS: Absolutely,
10 absolutely. Well, have we exhausted the usefulness of
11 this example, John.

12 DR. SCHROEDER: Yes.

13 CHAIRMAN APOSTOLAKIS: Wonderful.

14 DR. SCHROEDER: In fact, that's all that
15 I had prepared to show. The only thing that --

16 CHAIRMAN APOSTOLAKIS: Well, I still
17 hadn't seen though for this plant the CDF with its
18 uncertainty. Can we see that?

19 DR. SCHROEDER: Oh, yes, we can see that.

20 CHAIRMAN APOSTOLAKIS: And then maybe LERF
21 as well?

22 DR. SCHROEDER: No.

23 CHAIRMAN APOSTOLAKIS: Are you calculating
24 LERF?

25 DR. SCHROEDER: I can't do that. That's

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 not incorporated in this model.

2 CHAIRMAN APOSTOLAKIS: Okay.

3 DR. SCHROEDER: And that actually is an
4 issue that we'll talk about later.

5 CHAIRMAN APOSTOLAKIS: Okay.

6 DR. SCHROEDER: It's a model maintenance
7 issue.

8 CHAIRMAN APOSTOLAKIS: So let's just look
9 at CDF.

10 DR. SCHROEDER: Okay. I'll have to resell
11 (phonetic) the sequences here.

12 CHAIRMAN APOSTOLAKIS: Now, when you do
13 these changes, the code preserves somewhere the base
14 case that you've already done, right?

15 DR. SCHROEDER: Yes.

16 CHAIRMAN APOSTOLAKIS: Okay. You don't
17 have to go back and restore it.

18 DR. SCHROEDER: No. Well, in this case
19 I'm recalculating it because it's not easy to copy the
20 base case into the current case. It's really designed
21 to go the other way for comparison purposes. The
22 current case can be copied into the base case and used
23 as a later reference, but when I want to reestablish
24 the current case, I have to go and make a run, which
25 I've already done.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Okay. So let's
2 look at it.

3 DR. SCHROEDER: And I have to do the
4 uncertainty though, and I'll try 1,000 samples here.
5 Like I say, I don't know how far -- okay. This is
6 going fairly fast.

7 CHAIRMAN APOSTOLAKIS: So?

8 DR. SCHROEDER: Of course, the code is
9 having to recalculate all of the probabilities in the
10 model about 1,000 times for us, and it is taking some
11 time.

12 MR. DENNING: While we're waiting, you
13 know, we should have asked Dr. Shack's question
14 earlier.

15 CHAIRMAN APOSTOLAKIS: I did I thought.

16 MR. DENNING: Did you?

17 CHAIRMAN APOSTOLAKIS: They said they
18 follow 1150.

19 MR. DENNING: I guess that's right. So
20 they're not doing anything new.

21 CHAIRMAN APOSTOLAKIS: Okay. Here we are.
22 Base. Where are we looking, base or current?

23 DR. SCHROEDER: We're looking here.

24 CHAIRMAN APOSTOLAKIS: Okay. So it's ten
25 to the minus five and 95th is what? A factor of five.

1 Okay. I don't like the skewness value, but that's
2 okay. I think it's too high.

3 Do we really know that stuff so well, a
4 factor of five? And this is a plot of what?

5 DR. SCHROEDER: Well, this is --

6 CHAIRMAN APOSTOLAKIS: CDF?

7 DR. SCHROEDER: -- the probability density
8 function for the core damage frequency.

9 CHAIRMAN APOSTOLAKIS: It looks like
10 normal, huh?

11 DR. SCHROEDER: And, again, that's not a
12 lot of data points. It gets a little jaggy because
13 this plot really only uses 20 or 30 points.

14 CHAIRMAN APOSTOLAKIS: Okay. Good. Let's
15 move on.

16 DR. SCHROEDER: That was all that there
17 was in the demonstration unless there was something
18 specific you would like to see.

19 CHAIRMAN APOSTOLAKIS: Good, excellent.
20 This was very good.

21 So what's the next subject?

22 DR. BUELL: Major modeling assumptions was
23 the next topic.

24 CHAIRMAN APOSTOLAKIS: Are we going back
25 now to your slides?

1 DR. BUELL: Yes, going back to the slides.

2 CHAIRMAN APOSTOLAKIS: And that would be
3 Slide 31? Okay.

4 DR. BUELL: Okay. Given any PRA, you've
5 got to make assumptions on how you model what are some
6 of the key criteria. These are some of the major
7 model assumptions that we use in the SPAR model.
8 Okay?

9 And they're not ranked in order or
10 anything, but this happens to be no recovery of DC
11 power after battery depletion happens to be one of our
12 most important assumptions.

13 CHAIRMAN APOSTOLAKIS: And why is that
14 there?

15 DR. BUELL: Well, the reason that -- okay.
16 This is a legacy item that has been ongoing since the
17 beginning of the program, but what this assumption
18 says is after the battery is deplete, we're not taking
19 any credit for aligning power onto your emergency
20 buses again after that point.

21 And there's a variety of rationale that
22 goes underneath that. The fact that some of your
23 emergency lighting could be out, the fact that you
24 don't have remote control of your buses at that point;
25 you would have to manually bring them on, you know,

1 one at a time. It's a complex evolution.

2 CHAIRMAN APOSTOLAKIS: But I thought there
3 was a significant time to core uncover after that.

4 DR. BUELL: There is, okay, but like I
5 say, this is a limiting assumption right now that we
6 have that we're looking at, and this is one of our --
7 not only is it a major modeling assumption, but it's
8 a major modeling uncertainty as well.

9 CHAIRMAN APOSTOLAKIS: Now, is there also
10 uncertainty to the time of battery depletion?

11 DR. BUELL: Every plant has their own
12 battery depletion time basically.

13 CHAIRMAN APOSTOLAKIS: Seven hours, 12
14 hours? I mean, it's --

15 DR. BUELL: It goes anywhere from
16 approximate two hours to I think the longest we model
17 is 12 hours.

18 CHAIRMAN APOSTOLAKIS: So how do you
19 handle that?

20 DR. BUELL: We handle that explicitly in
21 the event trees.

22 CHAIRMAN APOSTOLAKIS: Do you use one
23 value or do you put uncertainty distribution on these
24 values?

25 DR. BUELL: There's uncertainty on the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 recovery values, but there's no uncertainty on the
2 battery --

3 CHAIRMAN APOSTOLAKIS: Why not? I mean,
4 what if the licensee says 11 hours and you suspect
5 it's more like seven?

6 DR. BUELL: We don't have any way to check
7 that. Basically we have to rely on what they tell us.

8 CHAIRMAN APOSTOLAKIS: Can't you put that
9 uncertainty distribution on the time?

10 DR. BUELL: We could run sensitivity
11 studies on that. We would --

12 CHAIRMAN APOSTOLAKIS: But not
13 uncertainty.

14 DR. SCHROEDER: There's no capability
15 right now to build that into the Monte Carlo sampling
16 scheme. It would require use of the plug-in
17 capability.

18 CHAIRMAN APOSTOLAKIS: Isn't that another
19 parameter though, John? I mean, why isn't --

20 DR. SCHROEDER: I said there's no
21 capability now, but it could be built into the DOL.
22 The plug-in capability is what we use to model these
23 things because they are specific to our application.
24 All it would take is a decision to go that direction
25 and it could be done. There's no real difficulties

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 there.

2 CHAIRMAN APOSTOLAKIS: Yeah, I mean that
3 would make much more sense, it seems to me.

4 DR. SCHROEDER: Of course, the biggest
5 difficulty is assigning the degree of belief to the
6 distribution, you know, determining a model.

7 CHAIRMAN APOSTOLAKIS: But I think it's
8 easier to argue about what the distribution is rather
9 than argue about what the right point estimate is
10 because then, you know, the stakes are higher. If you
11 put probability, even a small histogram, it doesn't
12 have to be a continuous distribution, you know. Two
13 or three or four values, and you know, you weigh them
14 appropriately. That probably would be a better and
15 easier way of doing it.

16 DR. SCHROEDER: Okay.

17 DR. BUELL: And that's something that
18 could be done, but right now we do not have that
19 capability in there, nor do we --

20 CHAIRMAN APOSTOLAKIS: Okay. Well, we're
21 here to help. We're here to help.

22 DR. BUELL: Okay. That's a significant
23 one, and one of the reasons it's significant is like
24 you indicated, you may have several hours beyond that
25 point for core uncovering (phonetic) core damage, but we

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 don't take any credit for that intervening period
2 beyond the battery life.

3 CHAIRMAN APOSTOLAKIS: And that also could
4 be something that would be handled probabilisticly.

5 DR. BUELL: That could be.

6 CHAIRMAN APOSTOLAKIS: Could be.

7 DR. BUELL: And we're going to deal with
8 that particular issue later on. Common cause is not
9 modeled across different systems. That's one of our
10 assumptions.

11 CHAIRMAN APOSTOLAKIS: That's a standard
12 assumption.

13 DR. BUELL: That's pretty standard. There
14 are some plants out there that try to do that, but
15 that's the exception rather than the rule.

16 Okay. Pre-accident human errors are not
17 modeled.

18 CHAIRMAN APOSTOLAKIS: Really? That means
19 during routine test and maintenance?

20 DR. BUELL: We do have fail to recover
21 equipment from test and maintenance, but this refers
22 to more like miscalibration of instrumentation level,
23 instrumentation, those type of --

24 CHAIRMAN APOSTOLAKIS: But if they do
25 maintenance and forget to reopen valves, that's part

1 of it.

2 DR. BUELL: We have that in our model.
3 That's explicitly modeled.

4 CHAIRMAN APOSTOLAKIS: So it's part of the
5 human errors.

6 DR. BUELL: That's correct, for failure to
7 recover equipment.

8 Okay. Basically we assume in station
9 blackout and LOOP events that all run failures occur
10 at time zero, and that's an issue that will come up
11 later on again.

12 CHAIRMAN APOSTOLAKIS: But not in other
13 initiating events? You don't assume that in others?

14 DR. BUELL: We do in other initiating
15 events, too, but typically this is where it's most
16 important.

17 CHAIRMAN APOSTOLAKIS: But, again, there
18 has been a series of very interesting reports coming
19 out of the same shop where analysts look at various
20 incidents that have occurred, and they look not only
21 at the unavailability of the thing, you know, on
22 demand, but also the unreliability over a period of
23 time, and then you can lump the two together if you
24 want and say this is the unreliability of the thing,
25 failed to start or it starts successfully and fails

1 some time later.

2 So I'm a bit surprised that you're not
3 including that.

4 DR. SCHROEDER: We are including that. I
5 think there's a failure to communicate exactly what
6 we're meaning by it fails to run at time zero. In a
7 cut set for, say, loss of off-site power station
8 blackout, you might have Diesel A fails to run and
9 Diesel B fails to run. Both are characterized by fail
10 to run in the first hour and fail to run during the
11 24-hour mission.

12 But that particular cut set at least with
13 respect to recovery considerations, both failures
14 occur immediately at the beginning of the loss of off-
15 site power. We do not try to attempt to do the
16 mathematics where Diesel 1 fails at ten hours and
17 Diesel 2 fails at 15 hours.

18 CHAIRMAN APOSTOLAKIS: But then how do you
19 calculate the probability of recovery, which is time
20 dependent?

21 DR. SCHROEDER: That's right. We assume
22 that there's a criterion that has to be met, for
23 instance, the time to core uncover and that it starts
24 at time zero when the loop occurs and the clock begins
25 running on that recovery.

1 There are mathematics that we have used in
2 the past to try to convolve (phonetic) the probability
3 distribution so that we assume -- we do an
4 integration, in effect, of the fail to run
5 distributions and the recovery time so that you get a
6 credit for Diesel A running for one hour and Diesel B
7 then failing at ten hours, and then the clock starts
8 running on our recovery at zero to whatever your
9 accumulated time is.

10 And if you integrate across all such
11 times, you're basically doing a convolution integral,
12 and we can't automate this easily. So we haven't
13 applied it now, but it would in the worst case give us
14 a reduction to 20 percent of the current run-run type
15 of cut sets. It's just very --

16 CHAIRMAN APOSTOLAKIS: So that time you
17 assume somebody has calculated, by doing the actual
18 calculation that involves the time dependent failure
19 of the diesels. I mean it can't be arbitrary. It has
20 to be related to that.

21 DR. SCHROEDER: The time constraint for
22 recovery is sequence and cut set dependent, and it
23 depends on what systems have operated and what
24 failures have occurred.

25 As I showed you in the station blackout

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 tree, this particular model might credit 14 hours, but
2 in the particular cut sets, that particular 14 hour
3 recovery is 14 hours from when the loop occurs. In a
4 particular cut set for that sequence, it may mean that
5 we can go 14 hours from when cooling is initially lost
6 or when the diesels initially fail, and if we go to a
7 convolution type technique, then we take credit for
8 all possible combinations of run-run failures, one
9 occurring at one hour and ten hours, two hours, 12
10 hours, all of that.

11 CHAIRMAN APOSTOLAKIS: But the assumption
12 of 14 must include in it some estimate of how long the
13 diesels might operate.

14 DR. SCHROEDER: The diesels in our model
15 have to operate --

16 CHAIRMAN APOSTOLAKIS: Even though you
17 don't include them.

18 DR. SCHROEDER: No, our diesels have to --

19 CHAIRMAN APOSTOLAKIS: You don't include
20 the actual time of failure. You don't model the time
21 dependent failure of the diesels. You are assuming
22 that they fail at time zero, but then you have an
23 assumption that as far as recovery of off-site power
24 is concerned, we are interested in 14 hours. Is it
25 going to be recovered in 14 hours?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 That number 14 must have come from some
2 kind of calculation.

3 DR. SCHROEDER: Right.

4 CHAIRMAN APOSTOLAKIS: And what I'm saying
5 is that that number probably includes an average time
6 for the diesels to operate.

7 DR. SCHROEDER: No, not in our models.

8 CHAIRMAN APOSTOLAKIS: So what did it come
9 from?

10 DR. SCHROEDER: For a given sequence, like
11 the sequence that I described that number would be
12 based on the battery depletion time because for that
13 particular sequence, the limiting issue is how long
14 the batteries will support operation of the turbine
15 driven systems.

16 CHAIRMAN APOSTOLAKIS: Well, yeah,
17 assuming that you have no AC power, which is a strong
18 assumption.

19 DR. SCHROEDER: Correct. Well, that
20 defined in the cut set. I mean we have many cut sets
21 for many different circumstances. In that particular
22 scenario I would have cut sets for two diesels failing
23 to start on demand, and I would have cut sets for one
24 failing to start on demand and another failing to run,
25 and then I would have one for the run-run failure.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 The mathematics of the start-start failure
2 are exactly correct. This assumption applies to the
3 run-run failure where we say that the clock starts
4 counting on recovery when the LOOP occurs, not when
5 the second diesel fails.

6 CHAIRMAN APOSTOLAKIS: So that's ignored
7 completely, the time until the second diesel failure.

8 DR. SCHROEDER: We ignore it in computing
9 the recovery. We don't ignore it in computing the
10 probability of diesel failure.

11 CHAIRMAN APOSTOLAKIS: But for the
12 recovery, it probably makes much more -- has more
13 impact.

14 DR. SCHROEDER: It has a big impact.

15 CHAIRMAN APOSTOLAKIS: And the utilities
16 have not complained about this?

17 DR. SCHROEDER: Yes. Now, some of the
18 utilities will actually do the convolution. What
19 you'll see out there is those that have four redundant
20 trains of emergency power feel no need to undertake
21 the complicated mathematics. Those that have two
22 trains feel a desperate need to undertake the
23 mathematics, and they pretty well do it.

24 CHAIRMAN APOSTOLAKIS: Yeah, you don't
25 have to do it exactly. I mean, you can have an

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 estimate of an average time. It doesn't have to be a
2 convolution, in other words. You take System 1 out of
3 two systems. You have the failure rate of the diesel
4 system. You say, "What's the mean time to failure of
5 this system?"

6 It's five and a half hours. Okay. I'll
7 use five and a half hours. So then the battery
8 deletion issue starts after five and a half hours
9 rather at the beginning.

10 That's a very simple way of doing it. You
11 don't have to go to complicated mathematics. In fact,
12 these formulas are available in books. So that's
13 something that you may want to think about.

14 DR. BUELL: Well, that's one of our issues
15 that we're going to address later on.

16 CHAIRMAN APOSTOLAKIS: So what you are
17 listing here is modeling assumptions that you plan to
18 revisit?

19 DR. BUELL: Some of these we'll plan to
20 revisit if they're significant enough. Some of them
21 definitely -- there are several of them here that we
22 are going to revisit. Some of them we're just stating
23 as a fact.

24 CHAIRMAN APOSTOLAKIS: Yeah, the CCF, for
25 example, you don't have to revisit. I don't think

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 there is any evidence that common cause failures
2 across system have been a problem.

3 DR. BUELL: No.

4 CHAIRMAN APOSTOLAKIS: But the time to
5 failure of the diesels I think is important because
6 the recovery curve for the off-site power is fairly
7 steep, as I recall. So by changing the time, you
8 change the probability significantly.

9 DR. SCHROEDER: We have a side technical
10 thread where we could demonstrate the method, but the
11 bottom line is that for a typical run-run cut set that
12 would be solved with convolution, the resulting cut
13 set is about 20 percent of the result that you would
14 get if you just assumed that the run-run failures
15 occur at time zero.

16 So we're missing on those particular cut
17 sets by maybe a factor of five, but while it sounds
18 real big, those run-run cut sets are only a small
19 fraction of all of the cut sets so that the impact on
20 the model isn't that big. It's something less than
21 that.

22 CHAIRMAN APOSTOLAKIS: Anyway, we can --

23 DR. BUELL: Anyway, this is one of the
24 issues that we'll talk about later also, but the next
25 item is failure of subsequent AC power recovery

1 station blackout sequences can be neglected.
2 Basically after you went to a station blackout once we
3 get power back on, we stop the clock. We say we've
4 got enough redundancy that the probability of those
5 failures is negligibly small. That's just an
6 assumption that we make.

7 CHAIRMAN APOSTOLAKIS: Good.

8 DR. BUELL: I know that's a little bit
9 optimistic, but we have looked at that issue, and it's
10 a pretty minimal impact.

11 Successful diagnosis is implied in all
12 sequences with a couple of exceptions. One is a steam
13 generator tube rupture where you have to diagnose
14 which generator it's in. The other one is in ISLOCA
15 events where you have to diagnose where your failure
16 was and try to isolate it.

17 Those are the two exceptions to that, but
18 in pretty much all of --

19 CHAIRMAN APOSTOLAKIS: What was the second
20 one? The second one was?

21 DR. BUELL: Is an ISLOCA sequences where
22 you're diagnosing where your rupture was and how to
23 isolate that. Everything else we assume that you are
24 in the right procedure and that you are following the
25 correct path.

1 Okay. The next one is instrumentation and
2 control, not explicitly--

3 CHAIRMAN APOSTOLAKIS: So how do you model
4 diagnosis in those two situations?

5 DR. BUELL: You do not model those
6 explicitly. We assume that they're followed. They're
7 in the correct procedure at that point. They're big
8 picture items.

9 CHAIRMAN APOSTOLAKIS: Oh. So then the
10 statement is correct. The successful diagnosis is in
11 naught (phonetic) sequences.

12 DR. BUELL: oh, with --

13 CHAIRMAN APOSTOLAKIS: In those two, in
14 those two.

15 DR. BUELL: In those two exceptions we
16 have an operator accident that we have generated based
17 on --

18 CHAIRMAN APOSTOLAKIS: Probability?

19 DR. BUELL: -- yes, based on the input of
20 trying to ascertain which generator you're in.

21 CHAIRMAN APOSTOLAKIS: So SPAR-H becomes
22 more and more important every day, huh? Yeah.

23 DR. BUELL: So anyway, yeah, we do go
24 through a detailed analysis.

25 CHAIRMAN APOSTOLAKIS: Who developed SPAR-

1 H? Who's the guy who will be presenting it?

2 MR. CHEOK: Dave Gooden.

3 DR. BUELL: The next one is
4 instrumentation and control is not explicitly modeled
5 for a variety of reasons. Number one is we don't have
6 that level of information. The other one is typically
7 it's not a driver as far as risk. Okay?

8 Errors of commission not modeled because
9 you can get into an infinite number of combinations of
10 that, and typically that's not been shown to be
11 important at least in the PRAs.

12 CHAIRMAN APOSTOLAKIS: That's where ATHENA
13 was supposed to help us, errors of commission.

14 DR. BUELL: Okay. Well, we don't model
15 that as part of the SPAR mode.

16 Limited recovery modeling, this varies
17 across the industry and the PRAs, but basically we
18 don't look at recovery modeling with a couple of
19 exceptions. In a station blackout we look at getting
20 off-site power back. We look at getting the diesels
21 back, and on a loss of service water, we look at
22 getting the system back. We don't give it much
23 credit, but there's some issues there.

24 Service water environmental issues are not
25 modeled. This has to do with water quality, and

1 that's something we're going to discuss in more detail
2 later. So we can go to the next slide.

3 Okay. Some BWR specific assumptions.
4 Containment binning, cause of loss of injection when
5 you're on the suppression pool, that's something that
6 we're looking at.

7 The next one, containment failure because
8 of loss of injection, that's something we're in the
9 process of changing actually right now. We're taking
10 some credit. The early modeling that we did, the 2QA
11 which was based on daily events, did not take any
12 credit for that. The NUREG 1150 took credit for that.
13 We're transitioning to more credit for that.

14 The problem is we have to depend on what
15 the PRA people at the plant tell us as far as a
16 success or failure probability on that.

17 Okay, and SORB --

18 CHAIRMAN APOSTOLAKIS: Rich, the time
19 available for this is long, right? To cool. I
20 remember it was four hours they said. They have to
21 initiate cooling in four hours?

22 MR. DENNING: That's what was used by
23 Marty.

24 CHAIRMAN APOSTOLAKIS: Yesterday.

25 MR. DENNING: Yeah.

1 CHAIRMAN APOSTOLAKIS: That's a long time.

2 MR. DENNING: That's correct.

3 CHAIRMAN APOSTOLAKIS: That's a long time.

4 DR. BUELL: And on PWR specific
5 assumptions we're already addressed all three of
6 these, except for the PORV challenge rate as not a
7 plant or initiator specific, and that's a data issue
8 that we haven't tracked down yet, but we make an
9 assumption that it is constant.

10 Next page.

11 The next section is the quality reviews,
12 and I can just continue on into that. The quality
13 review of the new models, we've looked at the history
14 before basically on the 2QA models. That was a peer
15 review subcontracted out. Sandia and SAIC did the
16 peer review of our Rev. 2QA models.

17 Okay. The next level of renew, we went to
18 all the plants in the country as part of the STP
19 process. We gathered information, fed that back into
20 our models, and in the most recent level of QA is
21 we're doing detailed cuts at level benchmarking
22 against the PRA results that we gather from the
23 plants.

24 So there's three different levels. As we
25 expand the models obviously we need to do additional

1 layers of QA, and we're doing that now.

2 MR. DENNING: Now, I'm not sure that as
3 far as the term QA or validation of the models or
4 verification -- validation of the models, I'm not sure
5 that you haven't combined two concepts here in that
6 under the second bullet, the QA reviews and detailed
7 procedure and independent analyst, okay, that's QA.
8 I mean --

9 DR. BUELL: Yes, this last step is not a
10 formal QA per se, but it does give us assurance of
11 correlation with the models or with what the plant is
12 expecting.

13 MR. DENNING: Right, okay. Now, with
14 regard to future change, let's go to real QA, and
15 that's with regards to as you make changes in the
16 models, what's the process of making sure that some
17 person doesn't screw it up?

18 DR. BUELL: I'm going to deal with that in
19 a future slide in a little more detail.

20 MR. DENNING: Okay. Then don't bother
21 with it now.

22 DR. BUELL: Next slide.

23 MR. DENNING: And I wanted -- okay. I
24 understand. You can go on.

25 DR. BUELL: In fact, this is the slide.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 Right now whenever we go in and let's say
2 an SRA calls us up. We're making a minor change, a
3 small change. We've got this. We've added this piece
4 of equipment, or we don't think that you've got the
5 power supply or whatever modeled correctly.

6 What we do is we get that information and
7 we incorporate that information, but we also have a
8 couple of additional items. I maintain an open items
9 list from previous calls or inputs from all the people
10 that give us input. That didn't get incorporated that
11 we have an open items list for basically that plant.
12 What issues do we need to resolve on the next
13 iteration?

14 So we go to that. We incorporate that
15 information, and then once we're done with that
16 information, we have a checklist of about 20 items
17 that we go and say, "Did we do this? Did we do that?
18 Do our results make sense?"

19 And so we go through this completion
20 checklist. It has also got some documentation issues
21 in there. Did we take care of that?

22 MR. DENNING: Who approves making a
23 correction to a model?

24 DR. BUELL: If they're minor, if they're
25 minor modifications, I do.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DENNING: And is there somebody then
2 that goes back? I mean, did you have a one-on-one
3 overview or somebody goes back in and they check to
4 make sure it was put in correctly?

5 DR. BUELL: I look at the results of the
6 model that goes out. Every model that goes out I look
7 at the results.

8 MR. DENNING: You look at the results.

9 DR. BUELL: The analyst does the analysis,
10 and then I look at the results to make sure that they
11 haven't changed significantly..

12 MR. CHEOK: And he has the follow-up to
13 that. I think, every time a model gets changed the
14 staff will also look at the results and go through the
15 models to make sure that we understand the changes.

16 MR. DENNING: Okay. Is that a detailed
17 review or is it kind of --

18 DR. BUELL: It depends on the level of the
19 modification.

20 MR. DENNING: Okay. I'm just getting a
21 feeling.

22 MR. MARKSBERRY: In some cases when
23 modifications are made to support a detailed, then an
24 ASP analyst or SRA would spend a week dissecting the
25 results just to make sure that the results make sense.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 So in most of the plant specific
2 modifications, there is a very detailed one-on-one
3 review of the mod.

4 DR. BUELL: And when we do global changes
5 like we just did with the seal LOCAL modeling and that
6 type of thing, it goes through a complete review
7 process before we do any global type changes.

8 Okay. The next level is model
9 configuration control. Right now this is an issue for
10 us as we're expanding the models. You know, LERF
11 models are built on the SPAR models. Low power
12 shutdown models are built on the SPAR models. Some of
13 these other peripheral applications are all built on
14 the Level 1 SPAR models.

15 So as people start using the models more
16 and more, controlling the base model is getting to be
17 more of an issue, and we're looking at implementing
18 some software controls, a library basic function that
19 allows you to check out a model to use before you can
20 make any changes to it. So that's just a programmatic
21 issue that we're looking at.

22 A model of software currency. The
23 software has a B&B process that they go through before
24 they give us a new version of the model or a new
25 version of their software.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 As far as the model itself, we go through
2 these steps and these procedures before we send it out
3 and also to whoever we send it. Typically it goes
4 through a detailed review also.

5 We also have a trouble reporting system
6 that John alluded to or mentioned earlier. They can
7 go in and formally file these issues, and we respond
8 to those.

9 And then the next step is lower -- the
10 process we're in right now is where we compare cut
11 sets from the industry to our SPAR models in this
12 proceduralized review, and we have a multiple page
13 procedure that we go through when we do that.

14 The purpose of the work that we're doing
15 now and these detailed cuts at level reviews is to
16 identify significant differences between our models
17 and their models and understand the reason why, and in
18 some cases they require modifications to the SPAR
19 models. Either we had incomplete information or the
20 information that we had was out of date, old,
21 whatever, and we can make some changes to our SPAR
22 models.

23 We're not trying to mimic the PRAs. We're
24 just trying to gather information from them, and this
25 is a very efficient way of gathering that information,

1 by looking at what they're saying is important and
2 seeing if we have similar issues.

3 We have several steps in the review
4 process. The first step in the review process is to
5 gather that information. Typically the plants provide
6 information all the way down to the normal truncation,
7 the normal truncation. That entails ten to 30 or
8 40,000 cut sets, and we take that information. We
9 reformat it, manipulate it to make it so that it will
10 load into SAPHIRE, and then once we get it into
11 SAPHIRE, it allows us to look at importance measures
12 and do filters and sorts on it.

13 The next key step in this process is we
14 identify approximately 150 of the most important basic
15 events in their model. We take their basic event ID
16 that corresponds to that model. We put that into an
17 alternate field that we have in SAPHIRE so that
18 there's a one-to-one link for these analogous events.

19 CHAIRMAN APOSTOLAKIS: Very good.

20 DR. BUELL: So we can generate a one-to-
21 one importance comparison for 150 of the most
22 important events, and if you pick these events
23 correctly, typically there may be 500 events or 600
24 events that show up at their truncation level, but if
25 you pick these events with a little bit of thought,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 these 150 events pretty much cover all of the systems,
2 all of the major issues that you need to cover.

3 So like I say, that's the next issue or
4 the next step that we do, is making that link, and
5 then I'll show you how we use that in a moment.

6 MR. DENNING: One second though, and that
7 is when you do that, do you often find cases where you
8 don't have an event that corresponds to theirs?

9 DR. BUELL: Yes, and that's part of this
10 whole process, is to try to understand why they have
11 an event. We look at their importance measures, look
12 at our importance measures.

13 In addition to just going down -- the
14 first step we do is we just do a sweep through all of
15 the systems, pick up the major components. Then we
16 look at their importance measures, everything that
17 they're saying is important. We're wanting to
18 identify everything that we're saying is important.
19 We want to identify it and make sure we have a good
20 one-to-one correspondence.

21 But, yes, we have added events in our
22 model because of what we're finding.

23 DR. SCHROEDER: Just as an aside on that,
24 the truncation issue has become rather important
25 because often we have components in our models that we

1 know they have in theirs, but they don't show up in
2 their cut sets. So we can't benchmark, say, our RHR
3 trained C against their RHR trained C. If they would
4 take a deeper cut, we could do it.

5 DR. BUELL: Most plants have a truncation
6 level of approximately ten to the minus 11, but there
7 are some plants out there that still have a ten to the
8 minus nine truncation. At that truncation we don't
9 have enough information to do a comparison of some of
10 the lower level events.

11 MR. DENNING: Is this automatically a
12 guarantee that the PRA is inadequate?

13 DR. BUELL: No, not in my opinion. I'm
14 not --

15 CHAIRMAN APOSTOLAKIS: No, I don't think
16 so.

17 DR. BUELL: I would not make that.

18 DR. SCHROEDER: And in fact, when you look
19 at the top 150 events, you spent probably five,
20 sometimes close to ten orders of magnitude on your
21 component importances, and that's getting down to
22 very, very small things, and Bob has plots that
23 demonstrate that.

24 CHAIRMAN APOSTOLAKIS: I'm afraid we're
25 going to have to stop now, a little ahead of schedule.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 I have to do something. So we'll continue at 1:30.

2 MR. DENNING: So we will have an hour and
3 a half you're saying?

4 CHAIRMAN APOSTOLAKIS: Yeah. I mean, the
5 schedule was an hour and 15 minutes or whatever.

6 (Whereupon, at 11:58 a.m., the meeting was
7 recessed for lunch, to reconvene at 1:30 p.m., the
8 same day.)

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

AFTERNOON SESSION

(1:29 p.m.)

CHAIRMAN APOSTOLAKIS: We are back in session.

Now, tell us please what the Birnbaum measure is. I know, but I forgot. What is the Birnbaum importance measure?

DR. BUELL: the Birnbaum is an important measure that if you take the cut set with it set to true --

DR. SCHROEDER: Yeah, its' F of one minus F of zero.

CHAIRMAN APOSTOLAKIS: Quiet please. Yeah.

DR. BUELL: It's a cut set with it set to one or to true, basically fail, versus it to set to false, and it looks at the difference between that.

CHAIRMAN APOSTOLAKIS: It doesn't use probabilities?

DR. BUELL: No, it does not. Basically it takes out the -- that's one of the reasons they use a Birnbaum. It looks at the maximum spread. If that event was set to true and to false, it looks at the maximum spread that you'll get there and gets rid of that variability in the Birnbaum.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Maximum spread in
2 what?

3 DR. SCHROEDER: In the core damage
4 frequency. It is the total core damage frequency with
5 the basic event value set to 1.0 minus the total core
6 damage frequency with the plant with the basic event
7 set to zero.

8 CHAIRMAN APOSTOLAKIS: Is that the risk
9 achievement worth?

10 DR. SCHROEDER: Risk achievement --

11 CHAIRMAN APOSTOLAKIS: Birnbaum does not
12 deal with probabilities I don't think. What you
13 described is the risk achievement worth.

14 DR. SCHROEDER: I guess I'd have to look
15 at the false. The risk achievement worth ratio --

16 CHAIRMAN APOSTOLAKIS: You set the
17 probability at one?

18 DR. SCHROEDER: It's a ratio. This is a
19 difference.

20 CHAIRMAN APOSTOLAKIS: So it's just the
21 difference.

22 DR. SCHROEDER: The difference.

23 DR. BUELL: From setting that event to
24 true.

25 CHAIRMAN APOSTOLAKIS: And why is that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 more important than RAW? I mean, RAW is the fraction
2 of change in the CDF.

3 DR. BUELL: they're similar, and we could
4 have used that.

5 CHAIRMAN APOSTOLAKIS: But everybody uses
6 RAW. I don't understand why.

7 DR. BUELL: The MSPI program is using the
8 Birnbaum also. So there's some correlation there.

9 CHAIRMAN APOSTOLAKIS: All right.

10 DR. BUELL: So where we left this last is
11 we had linked these basic events, the analogous basic
12 events come out of the PSA. We linked those to our
13 equivalent events in SPAR models, and what we're doing
14 in this whole review process is we generated some
15 metrics, and these are metrics that tell us that we've
16 spent enough time basically trying to understand the
17 issue.

18 And one of the metrics that we looked at
19 is when we look at theirs versus ours is our overall
20 CDF within a factor of two. Okay? This is just the
21 level of effort.

22 CHAIRMAN APOSTOLAKIS: Is this the mean
23 CDF?

24 DR. BUELL: That is correct.

25 CHAIRMAN APOSTOLAKIS: Not the point

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 value?

2 DR. BUELL: Well, it's the point value as
3 they report it to us.

4 CHAIRMAN APOSTOLAKIS: But there are
5 differences between the point value. How is the point
6 value estimated? By putting in point values for the
7 probabilities and you don't know what they are, right?

8 DR. BUELL: Yeah, we have no information
9 on their distributions.

10 CHAIRMAN APOSTOLAKIS: Can you ask them to
11 give you mean values? I'll make them do it. Because
12 the point values, I don't know. We want to use PRA,
13 but we don't want to do it rigorously.

14 And your results earlier that you showed,
15 John, there were slight differences between the point
16 and the mean.

17 DR. SCHROEDER: Yes. It varies much from
18 model to mode, but usually before we post a final
19 model one of our completion checks is to run the
20 uncertainty distribution and look at the difference
21 between the point estimate and the mean, and for a
22 typical SPAR model they're very close.

23 There are times when we spot a divergence
24 in those two numbers, and when we do we suspect
25 something's wrong and we look for it. There's

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 something that probably isn't right in the model if
2 there's a big difference between the point estimate
3 and the mean.

4 CHAIRMAN APOSTOLAKIS: Well, if you have
5 distributions that are very wide, in general the
6 results are different. If you have distributions that
7 have an error factor of three, then you don't expect
8 much.

9 DR. BUELL: For this level of comparison
10 we haven't looked at it in that depth. So when we're
11 all done with this process, our overall CDF within a
12 factor of two, we look at the conditionals for each
13 one of the initiators. That broadens out just a
14 little bit from about a .5 to a three range.

15 And then we have a dimensionless metric
16 that we generated that I'll show you here in a couple
17 of slides, and we use a .2 value. These were
18 determined based on level of effort and how much time
19 it takes to generate.

20 CHAIRMAN APOSTOLAKIS: Rich, I remember
21 from 1150 that the CCDP was practically between zero
22 and one. It was really a very wide conditional
23 probability. I mean, most of the cases I looked at it
24 was a very maybe not quite up to one, but it was way
25 up there.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DENNING: Well, what you're doing is
2 you're just talking about the initiating event
3 frequency.

4 DR. BUELL: That's right. This is a
5 conditional setting the initiator to one. We're
6 looking at the difference. Given you have an
7 initiator, what's your residual?

8 And we compare that --

9 CHAIRMAN APOSTOLAKIS: Oh, it's still core
10 damage.

11 DR. BUELL: That's right.

12 MR. DENNING: This is core damage.

13 CHAIRMAN APOSTOLAKIS: Oh, okay. It's not
14 containment. Okay, core damage.

15 MR. DENNING: Yeah, I was initially
16 confused about that, too.

17 DR. BUELL: Okay. So these are our
18 metrics that we've generated, and that's just to tell
19 us that we're close on the comparison or close enough
20 that we can stop the comparison.

21 CHAIRMAN APOSTOLAKIS: But I don't
22 understand that. Why are you allowing a higher number
23 here? I mean, do you think that CCDPs are what?

24 DR. BUELL: As you get to lower levels of
25 detail, the things that drive the differences

1 sometimes are such that they're outside of our charter
2 as far as how we model the models.

3 On the overall CDF, you know, you've got
4 some of them that are a little more conservative in
5 here, some of them that are not. Overall CDF, they
6 balance out a little bit, but as you get to these
7 lower and lower levels of detail, you know, the
8 nuances tend to make them lighter as far as the
9 comparison.

10 DR. SCHROEDER: Let me add a little bit
11 about, you know, an aside to what we just said. This
12 is one measurement per model. This is 15 or so
13 measurements per model. This is 150 measurements per
14 model.

15 So the number of comparisons implied by
16 each of these levels is varying in the order of
17 magnitude.

18 DR. KRESS: I guess George is wondering
19 why the .5 still shows up in that middle bullet. Why
20 isn't that different also?

21 MR. DENNING: Well, that would be a .3.

22 DR. BUELL: That would be a .3 if you're
23 consistent on either side of it. We didn't want to be
24 under, you know. If we're considerably less, if we're
25 throwing a CCDP that's less than there, that's

1 something you'd want to look at and not just accept
2 it. If we're a little bit higher on that, then that's
3 okay in our first cut, but if we're considerably lower
4 than they are, we just thought we'd look into that a
5 little more, in a little more depth.

6 CHAIRMAN APOSTOLAKIS: And the licensee
7 provides you all of this information that you need?

8 DR. BUELL: So far they have. That is
9 correct.

10 CHAIRMAN APOSTOLAKIS: You don't have to
11 do any calculations yourselves.

12 DR. BUELL: No. We just take it; we
13 format it and load it right into SAPPHIRE. There's no
14 calculations associated with that.

15 Next slide, please.

16 Okay. This is just a little more of a
17 description of the method. Basically what we do, if
18 our points or their points, if our model was identical
19 to their model with values and logic, what you'd end
20 up when you compare these Birnbaums, you'd have a Y
21 equals X line, slope equals one. It would be
22 identical. All of these points would be on that line.
23 Okay?

24 We don't have any ideal cases out there.
25 So what we've done is we've generated a metric that

1 basically just looks at the distance these points lie
2 from that Y equals X line, and we sum those up.

3 We also have a weighting factor because we
4 have such a wide range. A lot of cases we'll have
5 seven or eight orders of magnitude. You don't want
6 one point that's a little bit off at the top end
7 outweighing a million points at the bottom end. So we
8 have a logarithmic scale, a weighting factor that
9 we've looked at, and we incorporate into this metric.
10 Okay?

11 The next slide.

12 Basically this is a before picture. This
13 is a comparison of their model results to our model
14 results without us making any modifications. Okay?

15 And if you'll look at this line here our
16 metric, the distance from this line is what we're
17 measuring and summing up to give us that metric. So
18 as those converge on that Y equals X line, that metric
19 is going to get smaller.

20 And right now that metric is 1.9, and we
21 picked one that had a pretty broad range between what
22 we started with and what we finished, and you'll see
23 in successive slides that --

24 DR. KRESS: Do you add up all of the log
25 distances and divide by the number, then take the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 analogue?

2 DR. BUELL: That's correct. So you'll see
3 that there's quite a bit of scatter on this. Okay?
4 This is the starting point before, right as we loaded
5 the information into our models. Okay?

6 The next slide.

7 This slide you'll see that the scatter is
8 collapsed along the line. We've made the logic fixes,
9 but we haven't done anything with the data yet. Okay?

10 As part of this process, because there's
11 two variables in any model, there's the data and the
12 logic. To be able to just focus in on the logic, what
13 we do is we build a change set that includes their
14 data. It overlays our data with their data. It's
15 just a temporary thing. That way the data values are
16 not a variable any longer. We can just look at the
17 logic.

18 We haven't done that yet, but this is the
19 kind of math you would see after we made the logic
20 fixes.

21 CHAIRMAN APOSTOLAKIS: So if I take the
22 low point there between ten to the minus six and ten
23 to the minus five.

24 DR. BUELL: Okay.

25 CHAIRMAN APOSTOLAKIS: This the ratio of

1 your Birnbaum over theirs.

2 DR. BUELL: And you can see because it's
3 higher in ours that it's much more important in our
4 model than it is in their model.

5 DR. KRESS: And that's for a specific
6 basic event?

7 CHAIRMAN APOSTOLAKIS: Wait a minute.

8 DR. BUELL: That is correct. That's for
9 one basic event.

10 CHAIRMAN APOSTOLAKIS: Theirs is higher.
11 Therefore, it means that it's more important in your
12 model?

13 DR. BUELL: No. These are the SPAR
14 Birnbaums. That point right there is more important.
15 It has a higher SPAR Birnbaum than it does a PSA
16 Birnbaum.

17 CHAIRMAN APOSTOLAKIS: Well, so it's not
18 a ratio.

19 DR. SCHROEDER: No, it is a plot.

20 CHAIRMAN APOSTOLAKIS: Yeah, yeah.

21 DR. SCHROEDER: It's just a plot of the X-
22 Y values.

23 DR. BUELL: Yes.

24 DR. SCHROEDER: For instance, this point
25 that you called out, the SPAR Birnbaum value for that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 thing is like bigger than E minus six. The PSA
2 Birnbaum for that value is less than minus seven.

3 DR. BUELL: Is mid-minus eight.

4 So anyway, as we make the logic fixes, you
5 know, based on what we're finding in the cut sets, we
6 get a convergence as you'll see along this line.
7 Okay?

8 And the final comparison that I wanted to
9 show you is the same model that we have just seen in
10 the previous slide without the data variability. We
11 basically put their data in the change set,
12 superimpose that on our model, and you can see there's
13 a significant additional convergence on the model.
14 Okay?

15 So each one of these successive steps
16 shows a greater and greater convergence. Now, there's
17 some of these points, and if you'll look at the
18 metric, it's basically, like I say, you want that line
19 to be a heavy black line with all of those dots. The
20 greater the importance based on our weighting factor
21 is basically an angle from this point, from the one-
22 one point.

23 So the greater the angle, the more
24 important the points, and these four points here are
25 the most important points in the contribution to that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 metric. So we say, well, what are these points. What
2 do they relate to?

3 We look into that and try to see what's
4 driving those points, and that's what we do. This is
5 an iterative process. We look at their cut sets. We
6 look at our cut sets. These are the ones driving the
7 number. What's going on here?

8 And we continue to look at that, and for
9 these particular points when we go to the next slide,
10 they do have a story.

11 CHAIRMAN APOSTOLAKIS: So the most
12 important points are the ones on the upper quadrant.

13 DR. BUELL: Yeah, these because there's a
14 weighting factor. As you get closer to one, you want
15 a higher weighting factor. Those are more important
16 with the higher Birnbaums.

17 If you've got something down here, an
18 order of magnitude down here, ten to the minus seven
19 is not as important as an order of magnitude
20 difference at ten to the minus two. So we have a
21 weighting scale that goes along that.

22 CHAIRMAN APOSTOLAKIS: Yeah, sure.

23 DR. SCHROEDER: This is the triangle I
24 referred to in this morning's presentation where
25 there's increasing scatter at the bottom that we don't

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 attempt to address on the idea that it is just not
2 worth our time.

3 DR. BUELL: Okay. So like I say, I
4 mentioned that these four points have the biggest
5 contribution to that metric, and if we go to the next
6 slide, there is an explanation of what those events
7 are.

8 This goes back to some of these events
9 we've already mentioned, some of these differences and
10 uncertainties. Okay? It comes about from having the
11 diesel generator and DC bus failures are those points.
12 Okay? That's the analogous points, but what the
13 rationale is or why they're different is the fact that
14 there's much more credit for recovery of off-site
15 power in the St. Lucie model than what we give. Okay?
16 They've generated their own curves through recovery of
17 off-site power. We don't use those curves. We use
18 ours that we've generated in the SBO study.

19 So what that does is that gives much more
20 importance on the diesel generators because they can
21 recover power with a higher likelihood. We don't. So
22 our diesels are more important.

23 The same thing on the feed and bleed. ON
24 a loss of DC bus, you fail our feed and bleed in our
25 model because we require two PORVs. They only require

1 one PORV. So a DC bus is not that important to them
2 because it doesn't fail that additional heat removal
3 bath.

4 But in ours because it fails feed and
5 bleed, it's much more important in our models.

6 CHAIRMAN APOSTOLAKIS: So you will change
7 your model then?

8 DR. BUELL: No. We don't change them.
9 This is just an area we've understood the differences.
10 We're not going to go there. We have a standard
11 charter in the SPAR models. Two PORVs is our success
12 criteria. Unless we get detailed thermal hydraulics,
13 in fact, we haven't received any yet that we've
14 incorporated, but we use a two PORV success criteria.
15 That is our model.

16 CHAIRMAN APOSTOLAKIS: Wouldn't the
17 licensee in this case provide to you that thermal
18 hydraulic analysis.

19 DR. BUELL: If we pursued that further, we
20 could possibly get that information, but for now we
21 are, I guess, satisfied with using two PORV success
22 criteria.

23 CHAIRMAN APOSTOLAKIS: Because you're not
24 using it in any decision making situation, but if
25 there is a need for an SDP at St. Lucie 2, they're

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 going to fight you.

2 DR. BUELL: Well, at that point then the
3 SRAs will make that decision, and if they come back
4 and say, "We feel that there is sufficient
5 justification to use a single PORV success criteria,"
6 then we would --

7 CHAIRMAN APOSTOLAKIS: Well, why don't you
8 do it now? I mean, I don't --

9 MR. CHEOK: Well, George, I think the
10 issue is a little broader than described. A lot of
11 the licensees would be using the map code to justify
12 the two PORV and one PORV success criteria, and the
13 agency now has an initiative to look at the map code
14 to see if it's sufficient in quality to be used for
15 two-phase flow type success criteria determinations.

16 CHAIRMAN APOSTOLAKIS: The agency has
17 never reviewed the map code?

18 MR. CHEOK: We have, I think, agreed to
19 disagree at this point as to what the map code is
20 capable of doing, but we said that --

21 CHAIRMAN APOSTOLAKIS: But was it ever
22 reviewed?

23 MR. CHEOK: We looked at the map code, and
24 we had several decisions in the past, in the IPD
25 stage, where we said that we think that the GAP code

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 is good enough to use to identify vulnerabilities, but
2 for licensing applications, we will have to determine
3 on a case-by-case basis.

4 DR. KRESS: Yeah, the map code now is a
5 lot different than the one they had in IPE.

6 MR. CHEOK: That's correct, and we are
7 looking at the newer versions of the map code.

8 MR. DENNING: But whether it's appropriate
9 for use in determining success criteria is still an
10 issue.

11 MR. CHEOK: That's correct, and I guess
12 this is in a sense a little bit outside the scope of
13 the SPAR model development program because it's a
14 different initiative in the agency.

15 CHAIRMAN APOSTOLAKIS: You are not using
16 any other code. We just see whether what they did
17 with map is reasonable.

18 MR. CHEOK: At this point that's correct.

19 MR. DENNING: Do you also have a public
20 relations concern here that obviously it's important
21 to you that the utilities work cooperatively with you,
22 and I would imagine that if you turn every issue into
23 something that potentially looks to them like it's a
24 question of inadequacy, that they would not be as
25 cooperative with you, or do you not run into that at

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 all?

2 DR. BUELL: We haven't run into that. The
3 utilities have been very forthcoming with the
4 information. That has not been an issue to date, and
5 if you look at this, this has almost no impact on
6 baseline CDF, but it does have importance when you
7 look at a single component, you know, some of these
8 individual components.

9 CHAIRMAN APOSTOLAKIS: Or their sequence.

10 DR. BUELL: Say again? Or on a particular
11 sequence, and it has significant impact when you do a
12 determination with one of these components involved.

13 CHAIRMAN APOSTOLAKIS: Have you found many
14 instances where there was an issue of success
15 criteria?

16 DR. BUELL: Typically not.

17 CHAIRMAN APOSTOLAKIS: Typically not.

18 DR. BUELL: this is one of the examples
19 that at this point we just agreed to disagree on.

20 DR. SCHROEDER: One more observation on
21 this particular one. The reason that it is one of our
22 large structural uncertainties in the model is that if
23 you go and look at all of the plants that credit one
24 valve and all of the plants that credit two valves,
25 there is no discernable reason why. They could be

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 sister plants with virtually identical size and
2 capacities and the like, and one of them will credit
3 one PORV and the other PORVs, and when we look at that
4 what we see is that, well, one guy had an adequate
5 core damage risk without doing the additional analyses
6 and the other guy didn't.

7 So they did an expensive analysis to
8 demonstrate the capability, and we in Idaho don't have
9 the ability to review those analyses and determine
10 that they're adequate.

11 DR. THADANI: These valves are not really
12 -- I mean are they test data in terms of performance
13 of these valves under these conditions? I know the
14 Germans tested them, but I don't know of any other
15 place where they can say these valves would actually
16 perform properly.

17 DR. BONACA: Yeah, that's the question I
18 was asking before. I mean, would they stay open?

19 DR. BUELL: Well, it depends. Like I say,
20 under some circumstances the PRAs themselves do not
21 take credit formula if the supports are gone and that
22 type of thing. We don't look at it beyond this level.

23 MR. DENNING: And we probably shouldn't
24 either at this point since this is for review, but I
25 think it's really interesting and something we have to

1 keep in the backs of our minds here, and maybe there
2 are some lessons to be learned here, but obviously
3 it's not a SPAR question in that sense.

4 CHAIRMAN APOSTOLAKIS: What isn't?

5 MR. DENNING: It's a PORV question.

6 CHAIRMAN APOSTOLAKIS: No. The identity
7 of the model is a SPAR, isn't it?

8 MR. DENNING: Yeah, but you know, when we
9 get to these detailed questions of whether one PORV or
10 two PORV is necessary, as they've been saying, they
11 really can't get into that. That's too much of a
12 distraction. You know, they have to put together the
13 structural thing.

14 Now, eventually if the issue comes up
15 where it makes a difference, then they have to get
16 into it, and you know, NRR has to get into it.

17 CHAIRMAN APOSTOLAKIS: Well, I thought the
18 idea was to have SPAR models that are reasonable
19 presentations of the plants so we can use them. What
20 you're saying here is, yeah, there may be situations
21 where either the licensee or we are right, but we
22 don't know, and whenever we have to deal with them on
23 such an issue, then we'll decide.

24 But at the same time they are telling us
25 that there are not very many instances where they have

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 these differences. But I don't see. Maybe we can
2 just resolve it now.

3 But Mike said that they are going to get
4 the map code, right? And so perhaps there will be a
5 resolution then. Always Mike comes with a solution.

6 DR. BUELL: Like I say, at that point we
7 identify the top outliers and the reasons for those,
8 and that's the extent of our comparison, but you can
9 see throughout that progress or that progression that
10 there's quite a convergence, and most of the
11 differences are what we pick up in support system
12 information, and that's what --

13 CHAIRMAN APOSTOLAKIS: So the Columbia
14 seems to be different, 3.1, 6.3, 10 to the minus six.

15 DR. BUELL: Okay. What this table is is
16 the SPAR CDF with our normal template data that we
17 have, our final model with the normal data that we
18 have. Okay?

19 The next column is the completed model,
20 same model, only with the key data from the SPA, and
21 then the final one is the results as reported by the
22 utility themselves.

23 CHAIRMAN APOSTOLAKIS: So you're closer
24 when you use that data.

25 DR. BUELL: Yes. As you can see, we put

1 their data in. These converge.

2 CHAIRMAN APOSTOLAKIS: But I still don't
3 know why you have to give the column with the nominal
4 data. I mean then your SPAR model should be the
5 column before last. I mean if you agree with their
6 data -- this doesn't imply that you agree.

7 DR. BUELL: Yeah, this doesn't imply.
8 This is just a comparison. We're not saying we agree
9 with the data or we disagree with their data. We have
10 our own data analysis. Well, that will be taken care
11 of in the spring. I'll just let it go at that because
12 that's a whole discussion.

13 CHAIRMAN APOSTOLAKIS: And it's
14 interesting that for some plants the PSA of the
15 licensee gives a fire CDF, huh?

16 DR. SCHROEDER: That is often the case
17 once we apply the new SPAR template set. Our CDFs
18 tend to drop somewhat below what theirs are.

19 CHAIRMAN APOSTOLAKIS: Most of them seem
20 to be below.

21 DR. BUELL: With the exception of about
22 three of those, I believe, they're below, and one of
23 the reasons for that, like I say, it will be
24 elaborated on when the data is presented this spring,
25 but most PRAs use old generic data that they update

1 with plant specific data through a Bayesian process.

2 Okay. What that does is it shifts the
3 mean a little bit toward the plant specific data, but
4 essentially it's the old generic data. With the new
5 data that we used, we used a current five-year period,
6 and it is somewhat lower than what the old generic
7 data is, and there could be a variety of explanations
8 for that.

9 CHAIRMAN APOSTOLAKIS: It seems to me that
10 plant specific data should be used no matter what
11 Bayesian does. Plant specific data should be the
12 appropriate ones to use, and since you have done the
13 calculations, go with that.

14 MR. DENNING: Well, you're saying the
15 plant specific data is correct, and that isn't
16 necessarily true. I mean, I've seen plant specific
17 data that just when you put it all together doesn't
18 make sense.

19 I mean, I think --

20 CHAIRMAN APOSTOLAKIS:
21 Well, then there should be some mechanism to make sure
22 this doesn't happen, but I mean, again, if you look at
23 the experience of PRAs the last 25 years, they're
24 plant specific. They have to be plant specific.

25 DR. BUELL: Okay. Well, the plant

1 specific aspect of it, like I say, is just shifting
2 that generic data a little bit.

3 CHAIRMAN APOSTOLAKIS: Sure.

4 DR. BUELL: And there's no standard out
5 there for industry data collection and analysis as far
6 as what events get thrown out for nonapplicability and
7 that type. There's a lot of variability in the way
8 the different PRAs calculate plant specific data.

9 DR. SCHROEDER: One of the uncertainty
10 contributors that we have identified in previous
11 slides and we'll get to again is this issue of generic
12 versus plant specific. We don't exactly know which is
13 the most appropriate. The data collection effort is
14 demonstrating that depending on what snapshot you
15 take, the plants can look either very good or very
16 bad.

17 And if you take the wrong snapshot, just
18 a random snapshot, a plant could look horrible, and
19 there may be no real operational difference or quality
20 difference between the plant in this snapshot and the
21 plant in that snapshot. So what is the correct way to
22 deal with that issue?

23 That is something that the data people are
24 struggling with.

25 CHAIRMAN APOSTOLAKIS: What is it that

1 tells us that your nominal data are reasonable? You
2 have thrown out some stuff, too. I mean, it's not
3 that we are supreme beings and everybody hasn't been
4 making mistakes.

5 MR. CHEOK: You're right, George. I mean,
6 that's why I think we would like to come back to you
7 in the spring and the summer to discuss with you our
8 process.

9 CHAIRMAN APOSTOLAKIS: Mike is always
10 asking.

11 MR. CHEOK: We do have a process.

12 CHAIRMAN APOSTOLAKIS: You must have been
13 before this committee before.

14 MR. CHEOK: I think so.

15 CHAIRMAN APOSTOLAKIS: I think that's an
16 excellent point, and you get the flavor of the
17 questions you're going to get in the spring.

18 MR. CHEOK: Right. We're not a supreme
19 being. You're right.

20 CHAIRMAN APOSTOLAKIS: I have seen PRAS
21 when I was actually participating in the actual doing.
22 In one plant you have the generic distribution, and
23 for some components, in fact, there is a paper out of
24 it. Based here and pushed the distribution so high
25 because of that time we had to discotize (phonetic),

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 it really pushed it outside the range. The plant was
2 very bad from that point of view.

3 For other plants, it was what Bob said.
4 In most plants, in fact, in most components, you have
5 a slight shift, which is okay, but there are several
6 plants where this happened, and in fact, the question
7 that was raised then was is the plant really too bad
8 or is the generic distribution too optimistic.

9 Have you seen that paper?

10 MR. CHEOK: I'm not sure. I mean, I may
11 have.

12 CHAIRMAN APOSTOLAKIS: This is one of the
13 very early papers that came out. Well, hell, it's my
14 paper. Okay?

15 (Laughter.)

16 MR. CHEOK: I was going to say I wasn't
17 born yet, but --

18 (Laughter.)

19 MR. DENNING: You'd better move on.

20 MR. CHEOK: Let's move on here.

21 CHAIRMAN APOSTOLAKIS: The quality of your
22 comments reflect that. You're stealing mine, too.

23 DR. BUELL: Okay. this slide is just
24 something for reference. This is not a rigorous
25 analysis of this one here, but basically what I did is

1 I just took the mean of the ratios of the CDFs with
2 the PSA data to the PSA CDFs with their data. So that
3 kind of looks at the logic. I show that there's not
4 much difference in the mean, and there's not much
5 variance there.

6 I also did it with the nominal data,
7 looked at that column versus the PSA CDF. You see
8 that the mean drops down, which implies that the SPAR
9 with our data, you know, and the logic being
10 equivalent are the equivalence we can get is a little
11 bit less, and that implies that our data, if you go
12 down to these next two slides, our data that we're
13 using now tends to be a little bit lower than their
14 data. Okay? And there's a variety of reasons for
15 that. I just picked a couple of them that are
16 important.

17 The failure rates for the emergency diesel
18 generators are typically a bit lower than what the
19 industry is using. The turbine driven pumps is a
20 little bit lower than what the industry is using. The
21 transient initiating event frequency is a little
22 lower. Those are contributors.

23 There are some that are higher, too, but
24 in general these are things that drive it down lower.

25 Did you have question?

1 CHAIRMAN APOSTOLAKIS: Well, no, just a
2 comment. I want to reinforce what you said earlier
3 about, you know, how does one decide that something is
4 a failure or not, how to handle it, to include it, not
5 to include it. This is probably the most important
6 issue in data analysis. Once you decide what the
7 number of failure is, the number of tests is, the
8 Bayesian calculation is a matter of seconds, and I
9 remember in the old days they would send two or three
10 experienced engineers, the company that was doing the
11 PRA, to the plant where they would spend at least a
12 week going over the logs and deciding what is a
13 failure.

14 For example, when the utility replaces a
15 component because it's about to fail, but it has not
16 failed, is that a failure or not? Should it be
17 included or not?

18 They replaced it. It didn't fail. It
19 would have worked, right? But you know, being
20 cautious they said, okay, we'll replace it.

21 This issue was huge in the PRA that NASA
22 was doing for the shuttle last year because there, you
23 know, being a one of a kind system, every time they
24 see something they change the design process. So now
25 the guys quit doing the PRA come in and say, "Well,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 this failure counts as .1 of a failure."

2 Why? Engineering judgment, you know. In
3 other words, there are several reasons as to why you
4 should reject or include an apparent failure in the
5 database, and that is really a major issue, a really
6 major issue, and maybe you guys can think about it a
7 little harder because it does not affect on the plant
8 specific information. It affects the distributions,
9 too.

10 I mean, there is nothing magical about the
11 reactor safety study generic distributions, and I gave
12 you an example. In the plant there were many
13 components, surprisingly many that had failure rates
14 that were beyond the 95th percentile of the reactor
15 safety study distributions, which created a question
16 about the generic distributions themselves because one
17 or two you might say, "Well, okay. This plant is
18 really bad here," but consistently?

19 So I think this is something that as a
20 team we should spend more time on in thinking about
21 it. I don't know what else to say, but these are real
22 issues. I mean, I know the NASA folks had a hell of
23 a time, you know. The analysts would agree that,
24 yeah, we'll count this as a failure. A week later we
25 can't do that. Our managers disagree. They spend

1 half a million dollars fixing this, and you are
2 telling them it's still a failure?

3 And they had a point, too. They said,
4 "Why on earth did I spend all of this money if the
5 projection in the future accounts these things as
6 failures?

7 So that is a very important point, and I'm
8 glad we're getting back together in this way.

9 DR. BUELL: And this last bullet if you
10 look at we have a mean of 1.1 with the PSA data in,
11 suggests that we may be a little less optimistic than
12 they are. We've got some things that are a little bit
13 more conservative, possibly the two PORV success
14 criteria, no recovery out for battery depletion, but
15 you can see with that 1.1 mean that there's not much
16 difference.

17 CHAIRMAN APOSTOLAKIS: I think this is a
18 very -- my personal view now -- this is a very
19 detailed and thorough process that you guys have
20 developed to compare with the licensee because you are
21 using analysis, you know, sensitivity studies and so
22 on. That's very good. That's very good.

23 So ultimately the SPAR models will be
24 represented.

25 DR. BUELL: That's the intent, but like I

1 say, with specified differences that we just agree to
2 disagree on until we get further resolution.

3 CHAIRMAN APOSTOLAKIS: Yeah, sure.

4 DR. BUELL: Okay. I'll just roll right
5 into this next issue here. The modeling issue is
6 being worked. Some of these we've already talked
7 about at length. Some of them we haven't.

8 Where this list came from, we went around
9 and visited all of the plants in the country basically
10 as part of the STP process. During those visits we
11 looked at and tried to keep track of issues that when
12 we compare our model results to theirs we try to note
13 the differences as we went from Plant X to Y to Z.
14 We'd say, "Well, that guy did it this way. This plant
15 is doing it this way and it doesn't seem to be any
16 difference in the plant. Is that just an assumption
17 driven difference or, you know, who is modeling it?"
18 and everything.

19 But anyway, based on the information we
20 gleaned during those visits, we generated ten items.

21 CHAIRMAN APOSTOLAKIS: Isn't it surprising
22 that human error is not there? You mean they all
23 agreed?

24 DR. BUELL: That wasn't one of the issues
25 that was driving --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Really?

2 DR. BUELL: -- was driving the
3 differences.

4 CHAIRMAN APOSTOLAKIS: So maybe all of
5 them use the EPRI mysterious method. I can't believe
6 that human error is not an important modeling issue.

7 DR. BUELL: Well --

8 CHAIRMAN APOSTOLAKIS: Let's stop
9 immediately all of the work we're doing here.

10 MR. DENNING: Well, you know, again, as we
11 look at SPAR and what its use is, at the moment --

12 CHAIRMAN APOSTOLAKIS: No.

13 MR. DENNING: -- we're not going to have
14 human error be an important element in --

15 CHAIRMAN APOSTOLAKIS: That's not what
16 they're saying.

17 MR. DENNING: No, no.

18 CHAIRMAN APOSTOLAKIS: They're saying that
19 these were differences between you and the utilities,
20 right?

21 DR. BUELL: Yeah. Let me clarify that for
22 a moment. You know, possibly there's some obscuring
23 going on here. A lot of utilities use a dependent HRA
24 methodology that rolls up four and five and six events
25 into composite events, and they use them in different

1 combinations, and there's, you know, almost an
2 infinite number of combinations of these events that
3 they roll up.

4 So the HRAs or the HEPs are hard to
5 correlate and know exactly. You know, we have an
6 operator action. They had an operator action, but
7 because of all the dependency analyses and stuff that
8 are going on, it's awful hard to do a direct
9 comparison of our numbers versus their numbers.

10 Now, we didn't look at like a fossil
11 vessel (phonetic) of all of the ATPs or anything like
12 that in a rigorous way.

13 CHAIRMAN APOSTOLAKIS: But didn't you
14 subject -- you just showed us a very nice and detailed
15 staged or phased way of identifying differences, and
16 the human error didn't come out there?

17 DR. BUELL: Well, this was based on
18 information we gathered before we did any of these
19 types of analyses. We're early into that detailed
20 comparison process.

21 This was just a qualitative look at the
22 plants that we visit.

23 CHAIRMAN APOSTOLAKIS: I mean, one of the
24 striking results of the IPE lessons learned volume
25 NUREG was that the wide range of human error

1 probabilities was, in fact, in one plant the
2 probability of failing to initiate standby liquid
3 control was ten to the minus six or lower, and in
4 other plants it was ten to the minus three, and they
5 were almost sister plants. So that tells you that
6 there is tremendous difference in modeling, and I'm
7 surprised that it's not here.

8 DR. SCHROEDER: Well, I'd like to say
9 something about that. When we do the benchmarking
10 process, keep in mind the procedural steps we went
11 through. One of the procedural steps in trying to
12 align the logic is to apply their probability to our
13 events, and when you do that, those disagreements in
14 HEP values don't drive the metric. I mean by design
15 of our process, they are taken away.

16 What is checked is that we have an event
17 like their event, and it affects the overall structure
18 of the model in the same way. When we ship the model,
19 it goes with the SPAR-H method, and we don't really
20 care what they have. What we do --

21 CHAIRMAN APOSTOLAKIS: I don't understand
22 this.

23 DR. BUELL: Okay.

24 CHAIRMAN APOSTOLAKIS: I mean if you
25 compare your PRA, your SPAR, with their PRA and you

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 use a number like ten to the minus three from SPAR-H
2 and they use ten to the minus six, wouldn't you catch
3 that?

4 DR. SCHROEDER: We would, and if we go to
5 our plots like on a first St. Lucie plot -- let me
6 back up to that one if we can remember the page that
7 we're on here.

8 There might be HEP disagreements in this
9 range here. In fact, many of these things might be
10 HEP disagreements because we have a human error event
11 that looks like their human error event, for instance,
12 failure to initiate SLICK (phonetic), and if we were
13 E minus three and they were E minus two, or vice
14 versa, that would show up as a big disagreement here.

15 But when we apply the PSA data, that
16 difference would vanish if the logic model was the
17 same.

18 MR. DENNING: Now tell me. That means
19 you're effectively using their value for?

20 DR. SCHROEDER: For this part of the
21 comparison we're using their HEP.

22 MR. DENNING: Yeah, I meant in that part
23 of it.

24 CHAIRMAN APOSTOLAKIS: But that's
25 artificial.

1 DR. BUELL: And we've been focusing, and
2 the reason we do that is we've been focusing on the
3 structural logic of the model as opposed to the value.
4 So we've been purposely trying to get rid of the
5 variability in the value so we could focus on the
6 structure.

7 DR. SCHROEDER: And then when we finish we
8 go back and put in our data set with our SPAR-H HEPs,
9 and there may still be outliers related to those
10 events, but we will simply agree to disagree on those.

11 CHAIRMAN APOSTOLAKIS: But you have not
12 done this. I mean that --

13 DR. SCHROEDER: Yes.

14 CHAIRMAN APOSTOLAKIS: -- is something
15 that could be done, but you haven't.

16 DR. SCHROEDER: No, that's what we do.

17 CHAIRMAN APOSTOLAKIS: And I'm still
18 surprised that you couldn't find it. I mean you found
19 differences in CCF modeling, which you know, both of
20 you have an event that says common cause failure of
21 the thing. So it's the number that is different. So
22 I can't imagine that there weren't any human errors
23 that both of you had in the model, but the numbers
24 were different.

25 DR. SCHROEDER: There are many of those.

1 CHAIRMAN APOSTOLAKIS: Yeah.

2 DR. SCHROEDER: But they don't come to us
3 in our reporting to you as a modeling issue we're
4 concerned about because SPAR-H is our method and our
5 numbers are our numbers.

6 CHAIRMAN APOSTOLAKIS: So you are saying
7 this is not an issue because you have declared what
8 you're going to do anyway.

9 DR. SCHROEDER: pretty much.

10 DR. KRESS: No, they declare SPAR-H as --

11 DR. BUELL: As the preferred method.

12 Let me throw out one example. These are
13 our top ten issues. There is one HRA or HEP value
14 that falls down about 15th or so as we rank these
15 things, and that one issue deals with the initiation
16 of decay heat removal in a BWR. You know, we have
17 some ground rules that we use. Typically the utility
18 uses an order of magnitude or so lower than what we
19 use, and because BWRs are driven by decay heat removal
20 and you have that common operator action to initiate
21 those systems, that is one of the items that is on the
22 list, but it's down further. It doesn't show up in
23 the top ten. But that's the only one that we've
24 identified.

25 CHAIRMAN APOSTOLAKIS: But if you guys

1 resolve that issue by declaring that you will use
2 SPAR-H, why waste your time? Why didn't you do the
3 same thing here?

4 For PORV, it's two. For CCF it's alpha.
5 No issue. We're declaring that this is the way to do
6 it. So what's different about human reliability that
7 was handled that way from these?

8 MR. CHEOK: Well, George, I think even in
9 the industry PRAs they have different methodologies to
10 perform or to obtain HEPs.

11 CHAIRMAN APOSTOLAKIS: That's a modeling
12 issue.

13 MR. CHEOK: That's a modeling issue, and
14 we cannot, in essence, go to each PSA and adopt their
15 value because then we are saying we will now not be
16 standardized in our analysis because we are not
17 exactly adopting a single --

18 CHAIRMAN APOSTOLAKIS: No, no, no, no, no.

19 MR. CHEOK: -- methodology. We're just
20 saying the methodology --

21 CHAIRMAN APOSTOLAKIS: That's not what I'm
22 saying.

23 MR. CHEOK: -- we'll adopt at this point
24 is the SPAR-H for consistency throughout all of our
25 models.

1 CHAIRMAN APOSTOLAKIS: But you can still
2 identify it as a modeling issue.

3 MR. CHEOK: We could. You're right.

4 CHAIRMAN APOSTOLAKIS: Because what you
5 just said supports what I'm saying. Even the
6 utilities don't agree with each other.

7 MR. CHEOK: Agree. Okay. That's true.
8 I mean, I --

9 CHAIRMAN APOSTOLAKIS: It is a modeling
10 issue.

11 MR. CHEOK: -- I think what we're showing
12 up there in the list of ten is the issues that we
13 would work on.

14 CHAIRMAN APOSTOLAKIS: You know, this
15 issue will never be resolved in this agency. Why?
16 Because when we make important licensing decisions, we
17 don't scrutinize it. We just accept what the licensee
18 says.

19 When it comes to this issue, you're
20 dismissing it because you're going to use SPAR-H. The
21 decision makers, the Director of NRR or even the
22 Commission, maybe are not even aware there is an issue
23 there because nobody is telling them there is an
24 issue.

25 And they look here at nine important

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 modeling issues. Human error is not there. You know,
2 if I were Commissioner Merrifield, I would say at the
3 next budget cycle eliminate all work on human error.
4 My guys tell me that it's not important.

5 MR. CHEOK: It's a good point. I think
6 you bring up a good point, and we will have to either
7 caveat this list very well or --

8 CHAIRMAN APOSTOLAKIS: The reason why I'm
9 reacting to it is --

10 MR. CHEOK: You're right. I agree.

11 CHAIRMAN APOSTOLAKIS: -- not just because
12 of this, but as I said --

13 MR. CHEOK: You make a good point.

14 CHAIRMAN APOSTOLAKIS: -- licensing,
15 utilities requested extend power up rates. We all
16 know that the time available to the operator shrinks
17 a little bit, and then what? Well, that's okay, you
18 know, essentially, or the licensee says it goes down.
19 It increases by ten to the minus 100, and everybody
20 says that's fine.

21 Well, why then continue pursue doing a
22 better job? There is no reason.

23 MR. CHEOK: You're right.

24 MR. DENNING: I think it would be
25 interesting to look at your results and just ask the

1 question: how important was human reliability
2 modeling to the results? Because I think you've got
3 the data to answer that questions.

4 DR. BUELL: We can probably extract that.

5 MR. DENNING: If you kind of looked at --

6 CHAIRMAN APOSTOLAKIS: That's a very good
7 point, and also, have you guys consulted these reports
8 we keep referring to, the IPE reports?

9 DR. BUELL: In what respect?

10 CHAIRMAN APOSTOLAKIS: In insights, in the
11 insights gained.

12 DR. BUELL: Like in NUREG 1560 and those?

13 CHAIRMAN APOSTOLAKIS: I guess. You know
14 more than I do.

15 DR. BUELL: Yes, we have looked at those.

16 CHAIRMAN APOSTOLAKIS: I mean they've
17 clearly identified it as an important issue.

18 MR. CHEOK: I think we need to also
19 realize that in the past five years or so licensees
20 have gone through the certification process, and one
21 of the first things that the reviewers look at are the
22 HEPs and the HIPs, and sine the last five years,
23 there's a normalization or a condensation of the HEPs
24 so that we do not see that ten to the minus six was in
25 the ten to the minus three range.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: No, I'm sure they
2 changed that. They raised it, but still it was an
3 issue.

4 I mean, is it this subcommittee or
5 somebody else's subcommittee? We are meeting in
6 December on human error?

7 PARTICIPANT: Yes.

8 CHAIRMAN APOSTOLAKIS: Might as well
9 cancel it. It doesn't seem to be an issue, especially
10 since you've not done it.

11 I'm serious. Why should I come here and
12 waste two days on an issue that is irrelevant to the
13 agency?

14 MR. DENNING: Because you don't know, but
15 that's all right.

16 Okay. Incidentally, if you'd solve the
17 fifth one, that would help, too, I think.

18 CHAIRMAN APOSTOLAKIS: Now, you se, it's
19 so nice to number things when you have a long list
20 rather than putting bullets.

21 DR. BUELL: Okay. We'll do that.

22 CHAIRMAN APOSTOLAKIS: So I have to count,
23 number five.

24 DR. BUELL: Sump plugging (phonetic).

25 CHAIRMAN APOSTOLAKIS: Yes, sump plugging.

1 DR. BUELL: Well, like I say, these are
2 the top ten issues that we've identified.

3 CHAIRMAN APOSTOLAKIS: You've seen the
4 ACRS letter on that?

5 DR. BUELL: I have not.

6 CHAIRMAN APOSTOLAKIS: Then you will
7 insist on putting it number one.

8 DR. BUELL: Okay. Loss of off-site power
9 modeling, that was a big -- there's a lot of
10 variability in the industry. We've got an approach
11 now that we feel is adequate. You know, it may still
12 vary a little bit from what the plants do, but there's
13 a lot of variability within what the plants do.

14 So we have a solution. Maybe that needs
15 to be tweaked or whatever, but we do have a solution
16 for that.

17 RCP seal failure modeling --

18 CHAIRMAN APOSTOLAKIS: Are we going to
19 discuss each one?

20 DR. BUELL: Yes. I've got to explain each
21 one of these. I'll just go through them real quickly.

22 We've got the new WOG 2000 out there.
23 We've incorporated that information in. Common cause
24 modeling, it was being driven by alpha factors that we
25 had, some old alpha factors a little bit higher than

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 what the industry was showing.

2 Data values, we've got a standard template
3 that we use now. We've converged some on that.

4 Sump plugging, you know all about that.

5 Support system initiating fault trees.
6 We're working on a methodology or going to be trying
7 to work on that this coming year.

8 Power recovery after battery depletion,
9 we've touched on that one. You know, how much credit
10 can you give? We don't give any credit. The industry
11 gives some credit, and it has a significant impact at
12 some plants.

13 Continued injection after containment
14 failure. This is a BWR issue. How much credit can
15 you take for your continued injection after you over
16 pressurize and fail the containment?

17 PORV success criteria. We've beaten that
18 one to death.

19 And the time to core uncover, we're going
20 to talk about that also.

21 Like I say, we've put the issues we've
22 worked at the top and then going down the list, these
23 are some of the ones that we still need to address.

24 CHAIRMAN APOSTOLAKIS: Now, these are
25 being worked on because you found disagreements with

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the utilities?

2 DR. BUELL: Yes, disagreements between
3 utilities in conjunction with disagreements between us
4 and utilities.

5 CHAIRMAN APOSTOLAKIS: Okay.

6 DR. BUELL: So there was just a tremendous
7 variability, and these were important impacts on the
8 models. In fact, these are structural issues that
9 have a lot of uncertainty between models.

10 CHAIRMAN APOSTOLAKIS: So I suspect then
11 that the reason why errors of commission are not here
12 is because nobody is doing it.

13 DR. BUELL: That is correct.

14 CHAIRMAN APOSTOLAKIS: Wouldn't it be
15 though a modeling issue? Do you think that we have
16 resolved that, that the operators now have procedures
17 for everything? There is no possibility of
18 misdiagnosing anything? Is that a settled issue or --

19 DR. SCHROEDER: Well, let's address that
20 this way. The SPAR models don't necessarily reflect
21 original research on issues. What they are is a
22 compendia of things that we believe are mostly well
23 known, and we wouldn't know how to do the errors of
24 commission modeling. So they're not even on our radar
25 screen.

1 CHAIRMAN APOSTOLAKIS: I agree. I agree,
2 and it's not your job to do it. I fully agree with
3 your scope, but when you say important modeling issues
4 and status, you could say errors of commission TBD or
5 somebody is working on them, not us.

6 Notice I view this as a more general list
7 of modeling issues related to PRA, but apparently for
8 you it means something else.

9 MR. CHEOK: The title should probably say
10 modeling issues that are being worked on to make the
11 SPAR models more uniform with the licensee PRAs.

12 CHAIRMAN APOSTOLAKIS: More consistent
13 with licensee PRAs --

14 MR. CHEOK: That's correct.

15 CHAIRMAN APOSTOLAKIS: -- but if the
16 licensees also miss something, then you'll be happy to
17 miss it also.

18 MR. CHEOK: Well, remember we list it
19 under model assumptions in the beginning. We
20 understand that it's missing from our PRA or from our
21 model, and we list it there, and it's something that
22 we may have to work on later.

23 CHAIRMAN APOSTOLAKIS: Well, you know,
24 this is the first time actually that I see a
25 presentation from the staff where there is such a

1 thing on the screen, "modeling issues." Most of the
2 time we say, "Yeah, there are modeling issues we're
3 going to do something about."

4 And in fact, I believe Mary Drewing is
5 supposed to do something about it. Have you talked to
6 her at all?

7 MR. CHEOK: Yes, we have been talking to
8 Mary.

9 CHAIRMAN APOSTOLAKIS: So this is very
10 good actually. I mean, I really like this, but it has
11 to be -- well, first of all, as Mike said, the heading
12 has to be very clear what you're trying to do, but
13 this is an excellent opportunity to also say these are
14 the modeling issues. Maybe you can have a separate
15 list that says, "And here are broader modeling issues
16 that nobody knows how to handle. We have made the
17 assumption that you showed us earlier," and leave it
18 at that.

19 MR. CHOKSHI: I think, you know, as you
20 said, the problem that PRA issues, aging and other
21 effects, we are dealing within the context of --

22 CHAIRMAN APOSTOLAKIS: I understand that,
23 but it would be a good opportunity to document those,
24 although the human error probability we were talking
25 earlier about, I think, belongs here.

1 You're instigating very interesting
2 discussion, gentlemen.

3 DR. THADANI: Yes. Let me add one issue,
4 George, here and actually it's a question. If I take
5 a plant, a BWR, you have a SPAR model for that plant,
6 and I want to increase power level by 20 percent. I
7 suppose I could take success-failure criteria from
8 whatever the utility might say, but you can look at
9 that information and see the changes in available time
10 for operator actions and human reliability issues and
11 estimate change in core damage frequency.

12 DR. BUELL: If we had that information
13 from a particular --

14 DR. THADANI: The successful criteria you
15 would need, yeah.

16 DR. BUELL: And if it was different from
17 ours, we could feed that into our models and come up
18 with --

19 DR. THADANI: So because the times will be
20 narrower. So you could actually do a fairly quick
21 calculation, it seems to me.

22 DR. BUELL: Well, depending on, like I
23 say, the level of modification.

24 DR. THADANI: Sure.

25 DR. BUELL: But that could be done in the

1 SPAR model.

2 DR. SCHROEDER: That could be done, but it
3 would also presume that you understand all of the
4 consequences of that. I believe there's an ASP
5 analysis currently pending that deals with issues of
6 unforeseen circumstances of a power up rate, and we
7 wouldn't have been able to catch those any more than
8 anyone else would have.

9 DR. THADANI: Sure. No, I understand
10 that, yeah. Your structure allows that is what you're
11 saying. That's useful information.

12 DR. BUELL: Okay. I'll just go through
13 these next ten slides relatively quickly because they
14 deal with the details of each one of these. Okay. As
15 you noted up there, we said we had updated the models
16 for this particular issue. We've got new LOOP
17 recovery curves updated, the most current information
18 we have available or that can be generated

19 We have updated seal LOCA models. We've
20 included that in all of the PWRs based on WOG 2000 and
21 the other information as far as there.

22 We've changed our diesel generator mission
23 time to a 24-hour mission. We had some statistical
24 run time or our run times were based on some
25 statistical analysis. We got away from that.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: So I don't
2 understand. I'm sorry. I missed it.

3 DR. BUELL: We have 24-hour diesel
4 generator mission time, a standard 24-hour mission
5 time now. Before --

6 CHAIRMAN APOSTOLAKIS: So you would
7 calculate the unreliability for 24 hours --

8 DR. BUELL: That's correct.

9 CHAIRMAN APOSTOLAKIS: -- and put it up
10 front.

11 DR. BUELL: That's right. Before we had
12 varying time based on the plant location and
13 everything. It wasn't working out well.

14 CHAIRMAN APOSTOLAKIS: So now, you know,
15 as we were saying earlier trying to figure out the
16 mean value, if you have two diesels or three diesels,
17 each one -- well, the mean time to failure is
18 different though. You're going to get a long mean
19 time to failure.

20 That's okay. Go ahead.

21 DR. BUELL: Okay, and as part of the data
22 changes of the new template data, we have a two power
23 diesel generator hazard curve for failure at one hour
24 and greater than one hour, before it was a half hour
25 to two hours, and then greater than that. So we've

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 changed that.

2 CHAIRMAN APOSTOLAKIS: And that comes from
3 experience or --

4 DR. BUELL: That's what we're getting out
5 of the data, and like I say, I don't know the origin
6 of that.

7 CHAIRMAN APOSTOLAKIS: You mean they do
8 have tests where they run the business for 20 hours?
9 I thought most of the tests were a couple of hours.

10 DR. BUELL: I'm not part of the data
11 analysis.

12 CHAIRMAN APOSTOLAKIS: It's probably
13 judgment.

14 DR. BUELL: I'm not sure.

15 CHAIRMAN APOSTOLAKIS: It's okay. It's
16 okay. This is a preview of the questions for the
17 spring in color, in vivid color.

18 MR. CHEOK: We'll make sure we study the
19 tape before the spring so we can have all of these
20 questions answered.

21 CHAIRMAN APOSTOLAKIS: I should make sure
22 you do.

23 MR. CHEOK: We will make sure we do.

24 DR. BUELL: And this last item you just
25 touched on again, and we have talked about before.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 Some of the plants with only two diesels, they rely
2 heavily on involving the failure distributions to buy
3 more time. We don't do that right now. We have
4 methodology to do that, but we have not applied that
5 to our models, and that's just a judgment call as far
6 as the effort to get where we need to go, and there
7 are some other issues associated with that, but we
8 have not implemented that in our models.

9 But that's another issue where we deviate
10 from some of the plants. They use it, especially the
11 ones with only two diesels. We have not incorporated
12 that yet.

13 Okay. The next slide.

14 Everyone is familiar with the seal LOCA
15 modeling, I'm sure. The WOG 2000, we have
16 incorporated that into all of the Westinghouse plants.
17 The core uncover times are per the Westinghouse
18 emergency procedure guidelines. It's a generic curve
19 that we use. There is some variability based on the
20 number of loops you have in that outer thing, but it's
21 for our estimates. That's a pretty close estimate if
22 we use a single curve.

23 CHAIRMAN APOSTOLAKIS: So what are you
24 saying? When you say four seal failure modes with
25 probability and associated leak rates, what does that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 mean?

2 DR. BUELL: You have different stages.
3 You have staging within your seals, and they look at
4 the probabilities of failing this first --

5 CHAIRMAN APOSTOLAKIS: Oh, so you're just
6 describing what the --

7 DR. BUELL: It's within the WOG log --

8 CHAIRMAN APOSTOLAKIS: You're now telling
9 us what the agreement was.

10 DR. BUELL: That's correct, exactly.

11 CHAIRMAN APOSTOLAKIS: Okay, okay, okay.

12 DR. BUELL: I'm just replicating the WOG
13 2000 information. We've also got the CE information
14 in all of the CE plants, okay, and on B&W plants
15 typically they're either a Westinghouse or a
16 Combustion Engineering seal package in the
17 Westinghouse plants. We have put the appropriate --
18 and we have just done this in the last months -- we
19 have put the appropriate seal packages in the B&W
20 plants.

21 CHAIRMAN APOSTOLAKIS: Okay. So what was
22 the resolution?

23 DR. BUELL: The resolution was to put in
24 the new WOG 2000 and the pending information.

25 CHAIRMAN APOSTOLAKIS: To use the WOG 2000

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 model for all?

2 DR. BUELL: That's for all of the
3 Westinghouse plants.

4 CHAIRMAN APOSTOLAKIS: And the industry
5 agreed?

6 DR. BUELL: Well --

7 CHAIRMAN APOSTOLAKIS: You're using the
8 WOG model for CE plants?

9 DR. BUELL: No, no. There's a CE study
10 out there that's pending, and we were directed to put
11 that in pending final resolution on that.

12 CHAIRMAN APOSTOLAKIS: I don't understand
13 what the difference was. What was the disagreement?
14 I mean, your --

15 DR. SCHROEDER: Our previous SPAR models
16 had nothing like the WOG 2000 model in them. They had
17 an extremely simplified model that yielded very
18 conservative results.

19 So when the NRC issued a safety evaluation
20 report on the WOG 2000 model, we were directed to go
21 ahead and put that in as a replacement for the old
22 reactor coolant pump seal LOCA model that we had in
23 the models.

24 CHAIRMAN APOSTOLAKIS: I was under the
25 impression that there were at least two competing

1 models for RCP of the came manufacturer.

2 DR. SCHROEDER: There is a Rhodes model
3 yet, and that would be used for the very few cases in
4 which there are not high temperature seal packages.

5 CHAIRMAN APOSTOLAKIS: What you're telling
6 me is something different. You're saying we had a
7 conservative model before. Westinghouse had this
8 model, and then we were directed to go and use that.

9 MR. CHEOK: Well, we were directed -- yes,
10 we directed INL to do that because we now have an
11 agency position so to what seal models that we can
12 endorse. When Westinghouse submitted the topical to
13 use for their review, the agency reviewed the topical.

14 I guess I misspoke a little bit. The
15 agency reviewed the topical, and we wrote a valuation
16 report on that that says that we agree with your
17 model. In that case we said that we now have an
18 agency endorsed model, which we can now incorporate
19 into the SPAR model for Westinghouse plants.

20 CHAIRMAN APOSTOLAKIS: And the CE plant
21 is --

22 MR. CHEOK: Is close to endorsing a
23 similar topical report.

24 CHAIRMAN APOSTOLAKIS: And BW plants would
25 be one or the other.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. BUELL: They use one of those, too.

2 CHAIRMAN APOSTOLAKIS: It was never really
3 an issue of model uncertainty in the sense that there
4 were two or three competing models. Is that what
5 you're saying?

6 MR. CHEOK: I think at one time five or
7 six years ago there was a Westinghouse model and there
8 was a Rhodes model and there was a Sandia model.

9 CHAIRMAN APOSTOLAKIS: Yeah.

10 MR. CHEOK: And I guess there was
11 disagreement as to which is the best model to use.

12 CHAIRMAN APOSTOLAKIS: Exactly. That's
13 what I remember.

14 MR. CHEOK: At this point there is a
15 submittal to the staff, and the staff has looked at
16 the Westinghouse models and --

17 CHAIRMAN APOSTOLAKIS: Did Westinghouse
18 compare their approach with those other models?

19 MR. CHEOK: I am not sure.

20 CHAIRMAN APOSTOLAKIS: Is it possible --
21 I mean, you mentioned names. Rhodes?

22 DR. BUELL: There was the Rhodes model.
23 That was one of the models.

24 CHAIRMAN APOSTOLAKIS: Is that the fellow
25 whose name is Rhodes?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. THADANI: Rhodes is the Westinghouse.
2 He did that for Westinghouse. Limited testing was
3 done in Canada, but basically you don't have data for
4 beyond 30 to 45 minutes in terms of at these
5 temperatures and pressures, performance of these
6 seals, and so this is clearly large uncertainty in
7 whatever model you use.

8 DR. KRESS: There was a workshop last week
9 in Aux-en-Provence on uncertainties. You had some
10 people there, and I went. There wasn't much new on
11 model uncertainty, but there was one paper that talked
12 about using something called the Dempster-Schafer
13 theory on fuzzy numbers, and they claimed that that
14 was a better way to look at model uncertainty because
15 the distributions they use represented a whole family
16 of distributions rather than just one, and that they
17 claimed it to be a superior way.

18 I just wanted to call that to your
19 attention in case you wanted to get hold of that paper
20 from Basu. Sud Basu would have a copy of it, and you
21 might look into it.

22 I didn't have time to read it in detail to
23 see if their claims are real, but I know what they
24 claimed. They claimed it was a good way to do it.

25 CHAIRMAN APOSTOLAKIS: Can I comment on

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that?

2 DR. KRESS: Yeah, please.

3 CHAIRMAN APOSTOLAKIS: Don't do it.

4 DR. KRESS: Oh, okay.

5 CHAIRMAN APOSTOLAKIS: I think your
6 statement was correct, that they claim.

7 DR. KRESS: Yeah.

8 CHAIRMAN APOSTOLAKIS: But we have enough
9 problems with probabilities. You want to bring in
10 Dempster-Schafer? We would have Dempster-Schafer in
11 form regulations? Oh.

12 DR. BUELL: The next item on our list was
13 common cause modeling.

14 CHAIRMAN APOSTOLAKIS: Well, it's not
15 equivalent to MGL. They treat the data differently,
16 don't they?

17 DR. SCHROEDER: The equivalency that we're
18 referring to is that you can transform any alpha
19 factor into an MGL parameter through a series of
20 equations.

21 CHAIRMAN APOSTOLAKIS: But not the other
22 way, can you?

23 DR. SCHROEDER: I don't know.

24 CHAIRMAN APOSTOLAKIS: That's why they
25 developed the alpha factor. If they were completely

1 equivalent, they wouldn't. It's the way you handle
2 the data. Amazingly enough, it was a stupid way that
3 MGL would handle the data.

4 DR. BUELL: Well, the bottom line is we
5 were showing consistently higher common cause numbers
6 than the industry was, and it ended up being a data
7 issue, as we updated and expanded the data pool to
8 appropriate levels. That issue went away.

9 CHAIRMAN APOSTOLAKIS: And you guys have
10 this GEM thing that does the calculations. I'll tell
11 you most analysts that do things by hand are terrified
12 by the alpha factor model because you have a simple
13 one out of two system, and they tell you here is an
14 equation now that you have to use. Forget it. I'll
15 go with lambda beta gamma and I'm done, you know.

16 PARTICIPANT: Point, one.

17 CHAIRMAN APOSTOLAKIS: Point, one.
18 Actually there is strong evidence that the average is
19 .1. Ali Moseley developed some curves, and you know,
20 he was really remarkably close.

21 Only some valves tended to go to .2 in the
22 BWRs, but then again, for PRA .1, .2, I mean.

23 DR. BUELL: Okay. Next slide, please.

24 Another issue that we identified was the
25 data values. Typically in the past we had a little

1 bit higher data, but also the data was old and there
2 was significant differences sometimes in our data and
3 their data on a variety of data failure types.

4 So there's been a significant effort over
5 the last couple of years to generate new data for the
6 SPAR models, and we've got that in now. A lot of it
7 was based on system studies around 1990, and we've now
8 used EPIX based data, and you're going to get a
9 presentation on that in the spring.

10 MR. DENNING: Could you give us just a
11 little bit. What does EPIX based data mean there?

12 DR. BUELL: EPIX is a database that is
13 maintained by INPO that we have access to and we
14 analyze data out of that. It's a real broad database,
15 has failures, and I'm not a big guru on any of that,
16 but that's the source. It's an INPO maintained
17 database.

18 MR. DENNING: And what used to be national
19 reliability database or something, did that evolve
20 into that?

21 DR. BUELL: My belief is that that was the
22 predecessor to this.

23 MR. CHEOK: EPIX replaced NPRDS.

24 CHAIRMAN APOSTOLAKIS: You know, the first
25 paper that appeared proposing Bayesian update for

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 generic distributions was written by Stan Kaplan and
2 me in 1981. Why do I say that?

3 Because I have real problems with the
4 update. I'll tell you what. It's a property of Bayes
5 Theorem that no matter how wide your prior
6 distribution is you need very few real data to make it
7 very narrow. One failure in ten, 20 trials, whew, the
8 posterior becomes very narrow.

9 But if you go to the reactor safety study
10 which introduced the concept of generic information,
11 they don't claim that the distributions are broad
12 because of statistical uncertainty. They say they
13 represent plant-to-plant variability, and a range of
14 accident conditions.

15 Now, the plant-to-plant variability, you'd
16 say, well, if I use plant specific data, that's fine
17 because then I specialized in my plant, but what about
18 these accident conditions. I mean the long tail of
19 the log normally introduced was supposed to account
20 for those harsh environments, but all of your data
21 come from normal tests.

22 And what happens, of course, is you're
23 wiping out the long tail by using Bayes Theorem
24 because Bayes Theorem deals only with the statistical
25 uncertainty due to the fact that you don't have, you

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 know, a billion failures in a trillion trials, and
2 this is something that as a community we never really
3 paid much attention to.

4 But the truth of the matter is when you
5 specialize distributions using Bayes Theorem, you are
6 wiping out the long tail that the original guys in '72
7 said was there. I mean they justified the use of the
8 log normal. They said there were two fundamental
9 reasons. One was easy to work with analytically. At
10 that time they didn't have the computers we have now.

11 And, two, it skewed to the right, has a
12 long tail to account for these harsh environments, and
13 these harsh environments disappear the moment you run
14 two tests because the Bayes Theorem pushes everything
15 down.

16 And one idea that I had is maybe we can
17 separate this interval of high failure rates and don't
18 touch it. Use it as a generic distribution. Don't
19 update it with anything because you don't have any
20 data from those environments, and then the rest of it
21 update.

22 Now, somebody has to look into it in more
23 detail, but it seems to me that this is something that
24 we have perpetuated for the last 25, 30 years, and
25 Bayes Theorem does what it's intended to do, but our

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 generic distributions had a different meaning.

2 So I don't know if you guys want to think
3 about it. Maybe we can talk again about it in June or
4 whatever.

5 And, again, I appreciate that nobody has
6 done it, but I think it's an important point or maybe
7 you can come back and say we did it and we decided
8 it's not that important. Because that has to be
9 viewed in the context of another observation, that in
10 terms of the useful results from the PRA, namely, the
11 core damage frequency, of course, but also the
12 dominant contributors; the failure rates lambda are
13 not that important because of the extreme redundancy.

14 You see, it's common cause failures that
15 are important. Human errors are that important, but
16 whether you take a distribution of a lambda and you
17 stretch it a little bit, the fact that you have two or
18 three of those tends to diminish the significance of
19 that change.

20 So in the context of that, we have to
21 revisit the issue. Okay? And that's why we're paying
22 more attention to model uncertainty and all of that,
23 because we know that all success criteria -- I mean,
24 these are big things. These are big things that do
25 affect the results in the sense that the dominant

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 contributors might be different.

2 But the pool failure rate, I mean, because
3 for the shuttle that's not the case because they don't
4 have that kind of redundancy, you see. We do.

5 By the way, can you believe the number of
6 accident sequences contributing to the damage of the
7 shuttle? And they were all almost equally important.
8 In other words, single element minimal cut sets
9 surrounding to 1,300.

10 I'll tell you. The next time you see an
11 asteroid, kiss his hand.

12 (Laughter.)

13 CHAIRMAN APOSTOLAKIS: I mean, in PRAs for
14 reactors, the dominant contributors are less than 20,
15 and none of them is a single event sequence, right?
16 None of them; 1,300.

17 DR. BUELL: Okay. This last item is a
18 data value, but it's also a research issue that we're
19 looking at. Basically service water, water quality,
20 plugging. Nobody in the industry or very, very few
21 people try to address that. Yet there's been quite a
22 few plant shutdowns because of it, and from our
23 perspective, that's a significant issue that needs to
24 be addressed and needs to be looked at.

25 We're going through that this year. So

1 it's a data issue once we develop the way of looking
2 at that and trying to do a study on that.

3 Here's your issue here that you'd like us
4 to resolve. Sump plugging, all I did on this was
5 there's been a variety of numbers bandied about. This
6 is the last set of numbers that I heard. Maybe this
7 is way out of date, but if you take our initiating
8 event frequency times the conditional plugging
9 failure, these are the potential impacts in our model.

10 So you can see if you sum those all up,
11 you're about 1E to the minus five if the worst case
12 happens in all of these.

13 CHAIRMAN APOSTOLAKIS: What does that
14 mean? I'm not following that.

15 DR. BUELL: Okay. Basically what I did is
16 I took our initiating event frequency over there where
17 it says large LOCA. Okay? It's 5E to the minus six,
18 is our initiating event frequency, and the numbers
19 that I'm hearing, like I say, I know it's all replaced
20 with no set number, but the last number I heard for a
21 larger LOCA was .6 conditional of failing the
22 containment sump.

23 So if you multiply those together, you
24 have a potential 3E to the minus 6 increase in the CDF
25 using our frequency in the last set of numbers that I

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 heard.

2 Whatever this ends up being, if they're
3 large numbers like this, it could have a significant
4 impact. You're all aware of that. That's not new
5 news, but it is a big structural uncertainty in our
6 models right now.

7 MR. DENNING: What about the new large
8 LOCA frequencies, that kind of stuff? You have not
9 adopted that at this point, have you?

10 CHAIRMAN APOSTOLAKIS: The result of the
11 expert opinion in the solicitations?

12 DR. BUELL: No, we have not.

13 CHAIRMAN APOSTOLAKIS: Maybe you ought to
14 look at that.

15 DR. BUELL: Okay.

16 CHAIRMAN APOSTOLAKIS: You will find 20
17 different estimates. So good luck.

18 DR. BUELL: Okay. We're using the older
19 data from NUREG 5750 right now.

20 DR. SCHROEDER: The last that was talked
21 about I understood that was still in the review
22 process.

23 MR. DENNING: It is.

24 CHAIRMAN APOSTOLAKIS: I don't know about
25 that. I mean, the NRR guys are developing a rule

1 based on --

2 DR. THADANI: the proposed rule is out.

3 CHAIRMAN APOSTOLAKIS: Huh?

4 DR. THADANI: The proposed rule is out on
5 the streets now.

6 CHAIRMAN APOSTOLAKIS: Yeah.

7 MR. CHOKSHI: And that report is in our
8 component, the expert solicitation report. So --

9 MR. DENNING: It would certainly be
10 interesting to see what the implications are because
11 they're going to be big. I mean, I'm sure they're
12 going to further reduce.

13 CHAIRMAN APOSTOLAKIS: No, but you say
14 you're assuming ten to the minus six. That's on the
15 low side, I think.

16 DR. BUELL: Five E to the minus six for
17 large LOCA right now is the number we've got in our
18 models.

19 CHAIRMAN APOSTOLAKIS: Five? It depends
20 on how you combine expert opinions.

21 DR. THADANI: It's low, George. You're
22 right. It's low if you look at the expert
23 solicitation results. Plus I think this large LOCA
24 is a break larger than what, six inches roughly,
25 right? Basically, and if you look at the expert

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 elicitation, this is off by more than an order of
2 magnitude.

3 MR. CHOKSHI: Yeah, in that categories,
4 you know, greater than six, you're right.

5 DR. KRESS: But your main message is that
6 the effect on CDF is actually driven by frequency.

7 DR. BUELL: Well, it's a combination.
8 It's proportional to frequency and the conditional
9 plugging. So either one of those is going to adjust
10 the number.

11 DR. KRESS: Yeah, but the condition
12 plugging is -- I mean, we're only concerned about it
13 for the large break LOCA, and it's .6. So that makes
14 -- in PRA's place that's not much.

15 CHAIRMAN APOSTOLAKIS: Shouldn't you worry
16 also about LERF?

17 DR. KRESS: Yeah, you should, but --

18 CHAIRMAN APOSTOLAKIS: That's where you'd
19 probably see the bigger difference.

20 DR. KRESS: Yeah, it comes to kind of be
21 a long-term cooling issue.

22 DR. THADANI: But it affects the core
23 spray, too.

24 CHAIRMAN APOSTOLAKIS: The what?

25 DR. THADANI: The recirculation impacts

1 everything.

2 CHAIRMAN APOSTOLAKIS: Right, sure.

3 DR. THADANI: So I think George is
4 correct. It will have also significant effect on
5 LERF.

6 MR. DENNING: Well, will it or is it just
7 going to be late and not lead to early failure?

8 CHAIRMAN APOSTOLAKIS: Well, I mean, if
9 that's the case, you're saying that this is not a very
10 significant issue, right?

11 DR. BUELL: No. I'm just saying it can be
12 significant depending on what the final large LOCA
13 number is, what the final conditional plugging number
14 is.

15 Once that gets all resolved, it has the
16 potential to be as high as -- in fact, if you increase
17 the large LOCA probability, it could even be higher
18 than that impact on the models. It could be a ten to
19 the minus five impact on the models and increase.

20 DR. KRESS: I would be more than ten to
21 the minus five.

22 DR. BUELL: Yeah, if you increase the
23 large LOCA frequency it could be more than ten to the
24 minus five.

25 CHAIRMAN APOSTOLAKIS: But you will not.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 You will not. The expert opinion solicitation says it
2 is low. I think I misspoke earlier.

3 DR. BUELL: Okay.

4 CHAIRMAN APOSTOLAKIS: The large range
5 they show in that report is for LOCAs of a frequency
6 of ten to the minus five because the larger pipes,
7 what we now call large LOCA, have a frequency much
8 lower than ten to the minus five.

9 So I don't think that number is going to
10 go up significantly.

11 MR. CHOKSHI: No, but from the PRA
12 standpoint, it's a 16 -- this is large LOCA, right?

13 DR. THADANI: Exactly.

14 MR. CHOKSHI: This is not a double ended
15 pipe break.

16 CHAIRMAN APOSTOLAKIS: Eight inches.

17 DR. THADANI: It's six inches.

18 CHAIRMAN APOSTOLAKIS: Or eight. Anyway,
19 yeah.

20 MR. CHOKSHI: So but in the expert
21 elicitation, the number that they're deriving to the
22 different categories.

23 CHAIRMAN APOSTOLAKIS: Yeah.

24 MR. CHOKSHI: So but if you look at the
25 numbers from the six or 18 Gs, it's higher.

1 CHAIRMAN APOSTOLAKIS: It's higher. I
2 don't think it's a very low number, isn't it?

3 MR. CHOKSHI: Not at that range.

4 CHAIRMAN APOSTOLAKIS: It's less than ten
5 to the minus five.

6 MR. CHOKSHI: No. Well, we'll talk about
7 this, what distribution, and which --

8 CHAIRMAN APOSTOLAKIS: Well, the
9 aggravation of course makes a big difference.

10 MR. CHOKSHI: I think if I remember right
11 for PWR, and their base case was a ten to the minus
12 five was about seven inches.

13 CHAIRMAN APOSTOLAKIS: Eight.

14 MR. CHOKSHI: Yeah, seven or eight. You
15 are right.

16 CHAIRMAN APOSTOLAKIS: And then NRR says
17 14. That's good.

18 MR. CHOKSHI: So three at ten to the minus
19 five using the geometry was about --

20 CHAIRMAN APOSTOLAKIS: And plus I'm
21 correct. No, but is this finding, Rich and Tom,
22 consistent with the big deal the ACRS made on that
23 letter on the sump performance?

24 DR. KRESS: Well, we thought there were
25 issues of defense in depth that went beyond effects on

1 CDF

2 MR. DENNING: This is an accident within
3 the design basis at least current.

4 DR. KRESS: Yes, it is design basis space.

5 MR. DENNING: And of course, that .6 is
6 awfully close to "I don't know."

7 CHAIRMAN APOSTOLAKIS: One?

8 MR. DENNING: The .6 is "I don't know."

9 DR. KRESS: We actually thought for a
10 large LOCA that the condition was probably close to
11 one, and --

12 MR. DENNING: Could be.

13 CHAIRMAN APOSTOLAKIS: Well, that's why
14 they're certainly here.

15 DR. KRESS: It's close enough.

16 MR. DENNING: Yeah, but if this remains as
17 part of the design basis accident, if one were done,
18 it had better be a lot lower number than that or we're
19 not going to buy it.

20 MR. CHOKSHI: Once we resolve the issue.

21 MR. DENNING: Once we resolve the issue,
22 it had better be a much lower number than that. Let's
23 go on.

24 CHAIRMAN APOSTOLAKIS: Why? Is there a
25 cutoff thing for design basis accidents?

1 MR. DENNING: Well, it's not .5. I mean,
2 the probability that we would not be able to survive
3 a design basis accident? I mean it has got to be a
4 high degree of confidence. Point, five is not a high
5 degree of confidence.

6 CHAIRMAN APOSTOLAKIS: No.

7 DR. KRESS: That is the problem.

8 CHAIRMAN APOSTOLAKIS: There you would
9 have to postulate a single failure, right? It's a
10 design basis. You'd do a different kind of
11 calculation.

12 MR. DENNING: Analysis?

13 CHAIRMAN APOSTOLAKIS: Yeah.

14 MR. DENNING: Well, this is for a
15 realistic analysis here, which is probably --

16 CHAIRMAN APOSTOLAKIS: You would say I
17 have a large LOCA, and I will postulate the worst
18 possible single failure, and I should be able to
19 contain that.

20 DR. KRESS: That's what you do.

21 CHAIRMAN APOSTOLAKIS: This has nothing to
22 do with frequencies.

23 DR. KRESS: That's right.

24 CHAIRMAN APOSTOLAKIS: This has nothing to
25 do with frequencies. So I don't understand why it

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 would be lower when we're done with it.

2 MR. DENNING: Well, okay. They do a
3 realistic analysis. Okay? We do a licensing analysis
4 for the design basis accident, right? For that
5 licensing analysis, we put in a lot of conservatism
6 and it survives, right?

7 Well, when they do a realistic analysis,
8 then they're going to say, "Man, that's a really low
9 number, this probability that it's" --

10 CHAIRMAN APOSTOLAKIS: Oh, you mean --

11 DR. KRESS: That was the reason we put in
12 our letter that perhaps you ought to risk inform this
13 issue.

14 CHAIRMAN APOSTOLAKIS: And then you go to
15 these guys.

16 DR. KRESS: Yeah, that was the reason,
17 because we felt like that on the basis of CDF and LERF
18 that it probably wasn't that serious.

19 CHAIRMAN APOSTOLAKIS: And I have a hard
20 time believe it's .6, the condition of probability.
21 Huh?

22 DR. KRESS: Repeatedly.

23 CHAIRMAN APOSTOLAKIS: So high?

24 DR. KRESS: It won't be that high for a
25 BWR.

1 DR. BUELL: Well, it generated that
2 discussion on it, but the bottom line is that it could
3 have some impact on the results.

4 DR. THADANI: Well, you had a real event
5 with a BWR.

6 CHAIRMAN APOSTOLAKIS: Say again.

7 DR. THADANI: There was a real event at a
8 BWR, and we know what happened.

9 DR. KRESS: You plugged it in and spall
10 sump (phonetic).

11 DR. THADANI: It was called Barseback, and
12 we have had some partial events called that.

13 CHAIRMAN APOSTOLAKIS: It's still called
14 Barseback.

15 MR. DENNING: But it might not have been
16 under different circumstances.

17 CHAIRMAN APOSTOLAKIS: They shut down one
18 year. You remember that? Not because of this.

19 DR. KRESS: They fixed their sump.

20 DR. THADANI: Yes.

21 DR. BUELL: The next issue on our list
22 here is support system initiating event fault trees.
23 Okay. Right now the industry, probably two-thirds of
24 them -- I'm just going off, you know, experience
25 here -- probably two-thirds of them use initiating

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 event fault trees if you carry that information into
2 the model. One-third of them use a point value, and
3 there's pros and cons of both, but right now we use a
4 point value in SPAR models, and we use that value
5 based out of NUREG 5750.

6 There's a problem with that. The problem
7 is -- or several problems -- that you can get the
8 right CDF out of it, but when doing the MSPI program
9 and other programs, you don't get the correct event
10 importance because you're not getting the contributor
11 coming up through the fault tree on the initiating
12 event.

13 CHAIRMAN APOSTOLAKIS: So you're
14 supporting the fault tree approach.

15 DR. BUELL: We are, and we're looking at
16 researching that and developing that methodology.
17 Okay?

18 The other down side of using a point value
19 is you don't have any latitude based on system
20 configuration or levels of redundancy.

21 CHAIRMAN APOSTOLAKIS: Sure.

22 DR. BUELL: You're just using a generic
23 number.

24 CHAIRMAN APOSTOLAKIS: I don't think you
25 need to give anything, any argument.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. BUELL: Okay. Well --

2 CHAIRMAN APOSTOLAKIS: It is a system. It
3 has components. We analyze it.

4 DR. BUELL: Well, I'm just saying this is
5 a model uncertainty because right now we use a point
6 value. So we use the same that.

7 DR. BUELL: So we use the same number.

8 CHAIRMAN APOSTOLAKIS: But there's no
9 excuse for point values. Then why don't they do the
10 same with the high pressure injection system? Just
11 because it's front line?

12 In a PRA if you have a system, you analyze
13 it.

14 DR. KRESS: Like the control system?

15 CHAIRMAN APOSTOLAKIS: No. No, but this
16 is of the kinds of systems we analyze.

17 MR. DENNING: I agree. It's made up of
18 the same kinds of components.

19 CHAIRMAN APOSTOLAKIS: Yeah, hydraulic
20 systems, you know, pushing water here and there.

21 DR. BUELL: Okay. Well, like I say, this
22 is an issue that needs to be resolved at some point,
23 and we're looking at doing that.

24 CHAIRMAN APOSTOLAKIS: You just declare it
25 is all.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. SCHROEDER: One of the reasons this is
2 an issue is that in visiting many, many plants, we saw
3 the result of fault tree initiating event models that
4 predicted service water failures much, much, much
5 lower than we were seeing in the data.

6 So there was a huge question about whether
7 those were valid, and if we undertake that ourselves,
8 we have to be very careful to get something that is
9 consistent with the data.

10 CHAIRMAN APOSTOLAKIS: No, but that means
11 the fault tree calculations were not right.

12 MR. DENNING: Exactly.

13 CHAIRMAN APOSTOLAKIS: It doesn't mean
14 that you should switch the point values. Like with
15 anything else, you know, if you find discrepancies,
16 you question why and I'm sure you will find the
17 problem with their analysis.

18 DR. BUELL: And our feelings are, along
19 with the same issue, and we're going to get to it in
20 a minute, is that most plants do not look at the water
21 quality issues. The common mechanism of storm surges
22 and grass attacks and fish runs and the other myriad
23 of things that will shut plants down --

24 CHAIRMAN APOSTOLAKIS: You know, I really
25 think the major value of using PRAs is exactly what

1 you just said. There are people on opposite sides
2 questioning, debating detailed issues and so on. The
3 actual numbers I'm not sure are that important, but
4 now you will go to the licensee who doesn't do that
5 and say, "Water quality is important. Have you
6 thought about it? How do you handle it?" and so on.

7 I think this is really the value, that
8 it's a framework within which all of these issues come
9 up, and I think raises the level of safety that we
10 have. I really like that, the give and take that you
11 guys are having with the licensees.

12 MR. DENNING: Let me understand. With
13 your old approach the frequency of turbine trips,
14 things like that, would you not have modeled -- you
15 don't model that? Currently you just put in a value
16 for turbine trips or do you model?

17 DR. BUELL: No, currently we use a point
18 value for every initiator. We don't do any fault tree
19 specific modeling for those. Something like a turbine
20 trip would be extremely difficult because of all the
21 control systems and protective systems, but there are
22 some other systems like service water and some of
23 these other fluid type systems that are easier to
24 model and you can approximate.

25 DR. SCHROEDER: Not to be misunderstood,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 we have service water fault tree models now. We don't
2 use them for the initiating event frequency
3 determination. We use them in a support system
4 capacity.

5 The reason we don't use them for the
6 initiating event is that there are assumptions that
7 might apply to a 24-hour mission that wouldn't
8 necessarily apply to an initiating event calculation.

9 CHAIRMAN APOSTOLAKIS: So you would need
10 a different analysis.

11 DR. SCHROEDER: We need a different
12 analysis. It look very much --

13 CHAIRMAN APOSTOLAKIS: Well, that's fine.

14 DR. SCHROEDER: -- like the existing fault
15 tree, but it might be different in key ways, and one
16 of the things that we are planning to do is try to
17 settle that, and we would like to do it by achieving
18 a consensus with the industry, but in any event, we're
19 going to do it in some way that makes sense to us.

20 DR. BUELL: And two of those issues are
21 the basis approach or basic methodology. One of them
22 is a multiplier method where you use a regular 24-hour
23 mission time and you multiply it by a factor to get
24 the extended mission time for the year, and there are
25 some up sides and down sides with that.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 And the other one is to have separate
2 events for the year long mission time versus the 24-
3 hour mission time, and there are up sides and down
4 sides to that when you calculate importance measures
5 and all kinds of things.

6 So there's no perfect way of doing this,
7 but there is probably an optimal way, and we just need
8 to look at that and determine that. And that will be
9 going on at some point in the future.

10 CHAIRMAN APOSTOLAKIS: Very good.

11 DR. BUELL: We're down to the last couple
12 here. Power recovery after battery depletion is an
13 issue, and it has shown up in the MSPI comparisons.
14 SPAR models right now give no credit for power
15 recovery beyond battery depletion. Okay?

16 This is somewhat conservative, possibly
17 conservative. It does have a big impact on the SBO
18 CDF as well as the diesel importances.

19 MR. DENNING: I don't know the technical
20 issue here. What's really the technical issue?

21 DR. BUELL: Okay. The bottom line is you
22 typically do not do core uncovering for many hours
23 beyond battery depletion. There's also additional
24 systems that are not dependent on the batteries per se
25 for injection.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 You may have a plant that has a diesel
2 driven AFW pump. That pump can continue to inject,
3 you know. So you can actually also have seal failure.
4 You might go out 18, 20 hours --

5 MR. DENNING: So you wouldn't give any
6 credit at the moment --

7 DR. BUELL: We wouldn't give credit for
8 that because we're saying when the batteries go dead,
9 the complexity of the evolution to bring off-site
10 power back into the plant without having remote
11 control ability on those breakers --

12 MR. DENNING: And you can't really monitor
13 and know what's happening.

14 DR. BUELL: Yeah, and typically plants
15 have sketchy procedures at best. Some plants have
16 better than others.

17 Because of all the uncertainty there, we
18 have not modeled anything beyond battery depletion.
19 That has been our standard for many years, but it's a
20 big difference between us and some of the plants.

21 Now, a lot of the plants do go without and
22 say we're going to cut it at that point, but there are
23 some plants, you know, especially the ones that have
24 like diesel driven AFW pumps, you know. They're
25 saying, "Hey, I've got this system and I can't use it

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 because my batteries go dead." So they want a credit.

2 Some of the considerations down here, you
3 know, just off the cuff here, you know, diesel driven
4 injection sources, you know, how much credit should we
5 give for that? You know, availability and quality of
6 procedural guidance. You know, some plants just say,
7 "We'll give it 50 percent chance because we don't have
8 detailed procedures. We're not going to take much
9 credit for it," but they take a little credit for it.

10 There's other issues. You know, the
11 duration of emergency lighting. Can you realistically
12 say, "I'm going to get 20 hours of operation when I
13 can't see anything in the plant"?

14 You know, switch yard battery life.
15 There's batteries that a lot of plants have separate
16 batteries in the switch yard, you know. Manipulating
17 those breakers is much more complex than manipulating
18 four kV breakers. You can go out and pump up the
19 breakers with a small breaker. You don't do that with
20 a switch yard breaker.

21 So there are some of these issues that
22 we're looking at we're going to try to distill it down
23 to the key issues and see if possibly we can't change
24 that assumption that we fail at battery depletion.

25 But that is a big issue at some plants.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 At some plants it's not an issue at all, but the MSPI
2 program has identified this separately from us as an
3 issue, and I think he's going to be talking about that
4 later today, but we're looking at ways of resolving
5 this and coming up with an optimal way.

6 Here's a BWR issue that is a significant
7 issue at some plants. This issue deals with continued
8 injection after containment fails on over pressure.
9 You know, it fails. You've had a long term heat
10 removal failure. You've pressurized the containment,
11 and you fail the containment. If you have injections
12 or, let's say, CRD or some other injection source, did
13 you continue to credit after containment fails?

14 MR. DENNING: And when you say "fails,"
15 this is a hard vent that --

16 DR. BUELL: Yeah, this is either a rupture
17 or a tear in the containment itself.

18 MR. DENNING: But not a hard vent?

19 DR. BUELL: Not a vent. We look at that
20 separately.

21 MR. DENNING: Oh.

22 DR. BUELL: Now, that does have a similar
23 impact at some plants, but that's a separate issue.
24 So the bottom line is how much credit you give for
25 that continued injection can significantly impact your

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 decay heat removal importance for those components.

2 It can also significantly impact your
3 overall CDF for some BWRs. So some of the related
4 issues, you know, the environment, the steam, the
5 depressurization rate, you know, if it just tears
6 versus completely depressurizes, that eliminates some
7 of your low pressure injection systems because if you
8 sit there at 150 pounds and just bleed off enough
9 pressure, you're never going to get fire water
10 injection.

11 So there are some of these issues that
12 need to be resolved and looked at.

13 NUREG 1150 gives complete credit for that.
14 The old daily events manual didn't give any credit for
15 that, and we're transitioning towards more credit, but
16 we're looking at this issue in more depth.

17 The next slide.

18 Poor success criteria, we've already
19 talked about this one. John mentioned also I've
20 looked at as much information as I can find. I've
21 looked at plants that have identical relief capacity.
22 They have the same injection pumps, the same thermal
23 output. One will take two; one will take one as a
24 success criteria.

25 Now, that could be from the fact that they

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 just didn't want to put the additional effort into the
2 analysis or it could be that they ran an analysis. We
3 don't know, but there's a big variability in that
4 assumption.

5 CHAIRMAN APOSTOLAKIS: But you will find
6 out.

7 DR. BUELL: Say again.

8 CHAIRMAN APOSTOLAKIS: You will find out.

9 DR. BUELL: We will look into it, but I'm
10 not sure we'll get an answer soon on that one.

11 So next slide.

12 And this is the last of the ten issues.
13 This is time to core uncover. SPAR in the past has
14 been conservative and went -- if you didn't have any
15 information and you had no knowledge, you basically
16 went to a half an hour core uncover time. Okay?

17 That was a little bit too conservative.
18 What we did is we went and did a literature search,
19 tried to gather all of the old NUREGs, all of the
20 thermal hydraulic analyses that we've come up with,
21 put those in a master table, and take a composite or
22 extrapolate between those studies, and most of the
23 time now, even on a most conservative modeling it's
24 closer to an hour.

25 And that brought us closer in line to what

1 the industry was saying. So we identified that as an
2 issue. We went and made a reasonable fix. Short of
3 having any detailed thermal hydraulics, that's
4 probably an acceptable fix.

5 MR. DENNING: It does seem that this is an
6 analyzable problem, you know.

7 DR. BUELL: It is analyzable with enough
8 resources, and is it worth that effort is a question
9 that --

10 CHAIRMAN APOSTOLAKIS: Good.

11 DR. BUELL: So those are the top ten
12 issues that we have identified by going to all of
13 these different plants and comparing our models to
14 theirs. We've got a resolution for half of them
15 that's already incorporated. The other half we're
16 working on getting those fixed.

17 CHAIRMAN APOSTOLAKIS: Now, you're
18 beginning with your next slide, another topic, right?
19 Or you're going to?

20 DR. BUELL: I still have one. I thought
21 that was my last one. I have one additional slide
22 here. No, I've got a couple.

23 MR. DENNING: A couple.

24 DR. BUELL: Did you want -- okay.

25 CHAIRMAN APOSTOLAKIS: No, but these were

1 not part of the nine. Are these new?

2 DR. BUELL: Yeah, this is just a
3 continuation of the general topic. I did a slide for
4 each one of those, the bullets, and now I'm just
5 looking at general.

6 MR. DENNING: So three more slides. After
7 that would be a natural break point.

8 DR. BUELL: That's correct.

9 CHAIRMAN APOSTOLAKIS: Good.

10 DR. BUELL: Okay. I'll hurry through
11 these.

12 We talked about the loss of service water
13 initiating event frequency. A key element that we
14 don't see being modeled in these support system
15 initiators is water quality, and there's been 30-some
16 plant shutdowns because of those, including a couple
17 of service water failures. We just don't see that
18 being modeled in the PRAs. We need to come up with
19 some type of methodology that maybe they would
20 incorporate or something we at least feel --

21 MR. DENNING: This is like organic
22 contamination or some sort?

23 DR. BUELL: Yes. Debris loading silt,
24 fish runs, that type of stuff, collapsed trash rakes,
25 overloaded trash rakes, something along those lines.

1 MR. DENNING: Every one of them different.

2 DR. BUELL: Every one different, you bet.

3 Addition of low importance initiators. As
4 we went to these plants there's a lot of them that
5 were low initiators, one or two percent. We're adding
6 that as part of this MSPI or the detailed cuts at
7 level comparison.

8 We've changed our steam generator tube
9 rupture logic to include some benefit or some credit
10 for long-term RWST refill and continued injection. So
11 we made that change.

12 General modeling of common cause, we've
13 talked about that.

14 Simplified modeling of emergency diesel
15 alignments. We've made some modifications. This is
16 something that won't go away completely because of all
17 the myriad ways you can align diesel, especially if
18 you have many of them and a lot of cross-ties. We
19 just don't have the resources to model every possible
20 combination explicitly.

21 So what we do is we set an arbitrary
22 alignment that gives us the most benefit, and then if
23 there's an analysis, we let the analyst correct that
24 alignment for the alignment that he's actually
25 modeling.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 So there's just no way for us to
2 explicitly model every combination and look at that in
3 the base model.

4 So recent changes to the model that we've
5 made over the last year. We have put in the new CCF
6 alpha factors. We've linked and included new template
7 events. We've put in a new seal pump or RCP pump
8 logic. We've put in LOOP initiator logic as well as
9 off-site power recovery data, and we've converted from
10 the per hour to per year. Nobody likes the per hour.
11 so we made that conversion. So our results come out
12 on a per-year basis.

13 CHAIRMAN APOSTOLAKIS: So the question is
14 really who liked it.

15 DR. KRESS: Why was it there in the first
16 place?

17 DR. BUELL: Not very --

18 CHAIRMAN APOSTOLAKIS: Why was it there in
19 the first place?

20 DR. SCHROEDER: It was there because that
21 was the format used in the daily events manual, and
22 the only reason that it was there is that most of the
23 conditions that they were trying to evaluate for X
24 number of hours and it made the multiplication easy.

25 Along come computers, and you can automate

1 all of that, and we took the opportunity of a global
2 model update to change what had just festered for a
3 long time.

4 MR. DENNING: I think we accept that.

5 CHAIRMAN APOSTOLAKIS: You know, there is
6 always a reasonable explanation.

7 DR. BUELL: Future enhancements, things
8 that we're looking at right now and things that we're
9 doing. We're performing these detailed cuts at level
10 reviews.

11 We're splitting the transient event trees
12 into some sub-trees. That gives the analyst just a
13 little better definition. They're not relying on all
14 of these conditional probabilities.

15 We've added the new steam generator tube
16 rupture logic, the credit for RWST refill for those.

17 We are giving more definition for multiple
18 unit sites, for whether it's a single or dual unit
19 loop. That affects the cross-ties.

20 We've added the consequential seal LOCA
21 logic, and we're adding lower importance initiators,
22 anything greater than one percent.

23 We're adding additional detail. Before in
24 the PWR models, we had split fractions for main
25 feedwater. Now we're trying to do a more detailed

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 model, including the support systems.

2 We're standardizing the IS local
3 methodology for both Ps and Bs; benchmarking the PSA
4 test. That's our major task over the next year,
5 finishing up or continuing these detailed comparisons.

6 We're also -- the HEP calculator that you
7 saw John demonstrate in SPAR, that's a relatively new
8 edition. Now we've got to go back and take all of our
9 HEPs, put them into those shaping factors.

10 And we've talked about these items already
11 at the bottom here. These are pending resolution of
12 some outstanding issues. The initiating event
13 modeling, as well as integrating all of these models
14 into a single model that is based on the SPAR Level 1
15 model.

16 So that's some of the future plans we're
17 going to be looking at during this next year or so.

18 CHAIRMAN APOSTOLAKIS: Great.

19 DR. BUELL: And I think John is going to
20 talk to you about --

21 CHAIRMAN APOSTOLAKIS: Starting a new
22 topic now. So let's take a break until 3:25.

23 (Whereupon, the foregoing matter went off
24 the record at 3:06 p.m. and went back on
25 the record at 3:30 p.m.)

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Are you ready?

2 MR. DUBE: Well, good afternoon. I'm Don
3 Dube, and this is not a presentation on the MSPI.
4 It's really on the PRA quality reviews that we
5 performed as part of the MSPI implementation, and it
6 kind of follows on the presentation by John and Bob
7 regarding the SPAR versus licensees' PRA comparisons.

8 Along those lines we did something
9 similar, although in a very compressed time and a much
10 more narrow focus.

11 I'm just going to take one slide to
12 refresh your memory on what the MSPI is and why we
13 choose the Birnbaum as the measure figure of merit,
14 and in words, the MSPI is a measure of the deviation
15 of the plant system unavailability and component
16 unavailabilities from baseline values. So it's really
17 a delta.

18 But each unavailability or unreliability
19 is weighted by plant specific risk importance
20 measures. So the MSPI is the sum of an unavailability
21 contribution and an unreliability contribution. For
22 example, for the unreliability, a very simple
23 expression here would be B_1 times, in parentheses, the
24 unreliability of, let's say, a diesel generator
25 running minus the unreliability of a baseline diesel

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 generator based on an industry average failure rate.

2 So it's a deviation of plant specific
3 performance from the norm, but it's weighted by a
4 Birnbaum average. The reason why we choose Birnbaum
5 is because it falls out of the derivation, Birnbaum
6 being a change in core damage frequency for a given
7 change in unreliability.

8 And so when we perform the comparison,
9 since the Birnbaum of a basic event is a figure of
10 merit using the MSPI, it's ingrained in the MSPI
11 calculation and algorithm. It makes sense that what
12 we want to do is compare a Birnbaum value derived from
13 the SPAR mode with the Birnbaum value the licensee has
14 in their model and see if they make sense and if not
15 why don't they make sense.

16 CHAIRMAN APOSTOLAKIS: Now, the B_1 is what
17 makes this plant specific?

18 MR. DUBE: Correct. It falls out of the
19 plant PRA.

20 CHAIRMAN APOSTOLAKIS: Right, and baseline
21 values are the plant values. The UR_1 , the first term,
22 is the plant specific unreliability. The second term,
23 the minus term, is a baseline value that's an industry
24 average.

25 CHAIRMAN APOSTOLAKIS: Oh, it's not a

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 plant specific value.

2 MR. DUBE: No, it's an industry average.

3 CHAIRMAN APOSTOLAKIS: In the ROP I
4 believe we looked at the deviations from what the
5 utility has told us or in the maintenance rule. Isn't
6 that what we do?

7 MR. DUBE: Yeah, but this is -- the way
8 the MSPI was set up, it's a deviation from the
9 industry norm.

10 CHAIRMAN APOSTOLAKIS: And the industry
11 didn't complain about that?

12 MR. DUBE: No. They helped derive this.
13 No.

14 CHAIRMAN APOSTOLAKIS: Okay.

15 MR. DUBE: So that's all I want to say
16 about that, but to implement MSPI it was decided that
17 there were some quality requirements, PRA quality
18 requirements, that needed to be set. So a PRA quality
19 task group was formed of three NRC and two industry
20 members. Mike Cheok and Gareth Perry were two of the
21 five members, the names you're probably the most
22 familiar with.

23 And they came up with a set of
24 recommendations, and I provide this as background, why
25 we did what we did. They established two

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 requirements. The licensee should assure that their
2 PRA is of sufficient technical quality by (a)
3 resolving the A and B facts and observations from the
4 peer review.

5 What every licensee did for their PRA is
6 they had a team of reviewers from other contractors,
7 consultants, and utility representatives, and they did
8 a focused review on each licensee's PRA; came up with
9 a number of facts and observations, the As and Bs
10 being the most important because it could impact the
11 PRA quantitative results, whereas like C, for example,
12 might be a documentation issue.

13 So we said if you're going to move forward
14 the MSPI, you need to resolve those or at least go
15 through the ones that are not yet closed, that are
16 still open and explain why it would not impact the
17 MSPI approach, the method.

18 The second part was the performance self-
19 assessment using NEI 0002 endorsed by Appendix B of
20 Reg. Guide 1.200, which you've seen for the ASME level
21 requirements identified by the task group.

22 So what they had to do was say supporting
23 level requirements. There were 41 that were
24 identified from the ASME PRA standard that says we
25 believe these SLRs are important to the MSPI because

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 whether you met them or not, these requirements could
2 impact the MSPI in a quantitative way.

3 And licensees would have to do a self-
4 assessment and say, "Yeah, we meet all 41 of these
5 requirements," or if not, "this is why we don't think
6 it will have an impact."

7 CHAIRMAN APOSTOLAKIS: Isn't the PRA
8 review you're referring in A the one that is
9 implemented using NEI 0002? I think that's correct.

10 MR. CHEOK: Yes, that's correct.

11 CHAIRMAN APOSTOLAKIS: That's correct.

12 MR. CHEOK: That's why we require the B
13 part of it, so that they can reconcile the NEI 0002
14 to the ASME standards.

15 CHAIRMAN APOSTOLAKIS: Okay. So the Bs --

16 MR. CHEOK: B ties it back to the
17 standards.

18 CHAIRMAN APOSTOLAKIS: -- thing into the
19 picture.

20 MR. CHEOK: Correct.

21 MR. DUBE: Now, when the industry surveyed
22 their members, they found a substantial number would
23 not be able to meet both A and B and proposed an
24 alternative to B which was that they do a cross-
25 comparison of their PRAs, and I'll explain that in a

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 little bit.

2 CHAIRMAN APOSTOLAKIS: I don't understand
3 that. Why would they not be able to do this? I mean
4 it sounds like straightforward to me. Do they give
5 any reason?

6 MR. DUBE: I mean, it entailed quite a bit
7 of effort to do both.

8 CHAIRMAN APOSTOLAKIS: So it's a likely
9 amount of effort.

10 MR. CHEOK: I think it's a resource issue.
11 That's correct. I mean, they will require a lot more
12 effort to be able to meet A and B than they thought
13 was possible in the time that's needed for
14 implementation.

15 MR. DUBE: In the time frame.

16 MR. CHEOK: Right.

17 CHAIRMAN APOSTOLAKIS: So a cross-
18 comparison of PRAs is the alternative, but the PRAs as
19 they are today may be missing a few system level
20 requirements of the ASME code. So essentially you are
21 defeating B, right? Because the PRAs, a lot of them
22 were done, in fact, before the ASME code was issued.

23 MR. CHEOK: That's correct, but a lot of
24 the PRAs have gone back and backfit to be consistent
25 with the ASME code. So I think the process that Don

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 will talk about is they will do a cross-comparison
2 among themselves first before they make a submittal to
3 us, and after they make the submittal to us, we'll
4 make a cross comparison between their distribution and
5 our SPAR distribution, and Don will talk about that.

6 CHAIRMAN APOSTOLAKIS: But the ASME SLRs
7 are out. You are not going to go to the ASME SLR,
8 right?

9 MR. CHEOK: That's correct, but some of
10 the licensee PRAs would have gone through the ASME
11 SLRs.

12 MR. DUBE: They may have gone through
13 some, but not necessarily all.

14 CHAIRMAN APOSTOLAKIS: Again, a cross
15 comparison of PRAs. PRA presumably are plants of a
16 similar vintage.

17 MR. DUBE: Yes, right.

18 CHAIRMAN APOSTOLAKIS: So what if they
19 compare with five other PRAs? One of them has
20 included additional inputs and the four did not. What
21 do they do? Do they say, "Well, we'll ignore the
22 fifth one"?

23 MR. CHEOK: I think Don is going to
24 explain this.

25 CHAIRMAN APOSTOLAKIS: Okay.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: So the staff said fine, but to
2 have further confidence, we performed an additional
3 cross-comparison of the PRA Birnbaum values to SPAR
4 values and developed a process to do that.

5 You might not be able to read this, but
6 there was a logical, systematic process to identify
7 outlier Birnbaum importance measures, and it started
8 by compiling the industry Birnbaums, and for the MSPI
9 that represents about 5,000 components or 10,000
10 Birnbaums if you have two failure modes per component;
11 assigning them to plant groups based on similar plant
12 designs and vintages; identifying whether they were in
13 the appropriate group or not; if necessary,
14 reassigning them; and then if there were a substantial
15 difference between the Birnbaum values, they became
16 candidate outliers.

17 CHAIRMAN APOSTOLAKIS: Is it the same as
18 the figure that Bob and John showed us when they
19 compared the Birnbaums of the SPAR with the industry
20 PRAs? Is it the same thing?

21 MR. DUBE: Again, I have different -- the
22 same concept, but different approach, a little bit
23 different approach.

24 CHAIRMAN APOSTOLAKIS: Different approach.

25 DR. KRESS: They use the same metric?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: We're using the comparison of
2 the Birnbaum values, right.

3 CHAIRMAN APOSTOLAKIS: Well, that's what
4 they did. So what's the difference?

5 MR. DUBE: Well, you'll see.

6 CHAIRMAN APOSTOLAKIS: Oh, I will. I
7 will.

8 DR. KRESS: We'll wait.

9 MR. DUBE: If there was a candidate
10 outlier, then we did forensic PRA and try to determine
11 if it was because of an identifiable design
12 difference, and if so, we reviewed the modeling of
13 that. That's the first decision box there, the
14 diamond.

15 If not, was it because of an operational
16 feature, such as electrical cross-tie procedure,
17 emergency operating procedure or something along those
18 lines? And if not, was it because of an identifiable
19 modeling method difference?

20 CHAIRMAN APOSTOLAKIS: Can we have a full
21 page copy of this figure? It's impossible to read it.
22 Not now, but I mean when I go home and I want it.

23 MR. DUBE: So the Westinghouse owners
24 group and the BWR owners group did cross-comparison,
25 and here I'm just showing one graph. It's a little

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 bit busy, but one graph, and I kind of hid the plant
2 names, although this is generally proprietary Class 3,
3 which means it's not proprietary.

4 Each group of bars --

5 CHAIRMAN APOSTOLAKIS: Mr. Reporter, can
6 you hear? Okay.

7 MR. DUBE: Each group of bars is one
8 plant, and each individual bar is the Birnbaum value,
9 and this is on the scale of ten to the minus six, ten
10 to the minus five, ten to the minus four for the
11 emergency diesel generators, and what you see kind of
12 naturally falls out is that these are the group of
13 Westinghouse and Combustion Engineering plants with
14 two emergency diesel generators. These are the plants
15 with three emergency generators, and these are the
16 plants with more than three diesel generators.

17 And also plotted on here are mean values,
18 median values. And what you see is the Birnbaum
19 values is a strong function of plant design and for
20 diesel generators, a strong function of the number of
21 emergency diesel generators.

22 What that basically means is two diesel
23 generator plants have on average Birnbaum values that
24 are higher than three diesels, which is higher than
25 four or more, meaning that the core damage frequency

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 is very sensitive to the performance of a diesel
2 generator.

3 And given that you have two diesel
4 generators, one diesel generator is more important to
5 a two-diesel plant than it is to a three-diesel plant
6 or four. I mean, it kind of makes sense.

7 CHAIRMAN APOSTOLAKIS: Is the plot the
8 birnbaum for a single diesel?

9 MR. DUBE: yes.

10 CHAIRMAN APOSTOLAKIS: Regardless of how
11 many they have.

12 MR. DUBE: Right. And this sump asymmetry
13 in some cases is three because they also included a
14 non-safety related like a station blackout diesel to
15 show its value just for purpose -- even though it's
16 not in the MSPI.

17 CHAIRMAN APOSTOLAKIS: Let's take the two
18 extremes or maybe the first one on the left and the
19 third one from the end.

20 MR. DUBE: This one?

21 CHAIRMAN APOSTOLAKIS: Yeah, this one and
22 the third one. No, the other one, all the way down,
23 all the way to the right, the third one.

24 MR. DUBE: This one?

25 CHAIRMAN APOSTOLAKIS: The third one.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 They seem to have the same Birnbaum. How can a diesel
2 generator in a four diesel plant have the same
3 Birnbaum as a diesel generator in a two diesel plant?

4 MR. DUBE: Well, this shows the category-
5 to-category variation, but what it shows is within
6 here there may be other plant specific -- it could be
7 one of three things: a real design difference, a real
8 performance difference in terms of failure to run and
9 failure to start rates or a mod difference (phonetic).

10 CHAIRMAN APOSTOLAKIS: Most likely the
11 latter unless the numbers are completely off. I mean
12 how can, you know, one out of two systems, a
13 component has a certain importance. You know, one out
14 of four you just have much less importance.

15 MR. DUBE: Well, what you find is it's a
16 combination of the three, and the reason why we use
17 the SPAR models as a benchmark -- Bob and John kind of
18 mentioned that -- is that it removes two out of the
19 three factors. It removes data because we're using
20 the same performance data in the SPAR models. It
21 removes modeling differences because we're using a
22 standard process, and what you see in the SPAR model
23 is what's left is really primarily design difference.

24 So what we do by comparing the SPAR
25 Birnbaums with the licensee's Birnbaum is remove two

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 out of those three differences, and --

2 CHAIRMAN APOSTOLAKIS: There may be real
3 differences, right?

4 MR. DUBE: Yes.

5 CHAIRMAN APOSTOLAKIS: Still though,
6 wouldn't it be interesting to find out why these two
7 seem to be the same?

8 MR. DUBE: And that's what we do based on
9 the process that we used, which was we were concerned
10 with outliers where the industry's value deviated
11 significantly from the norm within its group and
12 significantly from the SPAR value, and we had a set of
13 criteria that went through all 5,000 components; used
14 a screening approach to say which ones had significant
15 deviation, and then dove into the model, the cut sets
16 and looked at the modeling differences; determined if
17 it was a design difference or a modeling different
18 that would explain the difference between the Birnbaum
19 values.

20 CHAIRMAN APOSTOLAKIS: So you're
21 investigating the causes.

22 MR. DUBE: The reason for the differences.

23 CHAIRMAN APOSTOLAKIS: Yeah.

24 DR. KRESS: You're looking for something
25 outside of the range of --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: Outside of the norm.

2 DR. KRESS: -- outside of the red.

3 CHAIRMAN APOSTOLAKIS: Even within the
4 class, significant differences, huh?

5 MR. DUBE: That's right, and when you dig
6 down to it you find this particular plant, for
7 example, might have installed independent reactor
8 coolant pump seal cooling capability so that in the
9 event of a station blackout they would line up with,
10 say, fire water or some other system to cool the
11 reactor coolant pump seal, or they may have had
12 installed some other AC independent system. In other
13 cases, you may find that they installed an independent
14 cooling system for a charging pump that provides that
15 cooling pump.

16 But you find that there may be very real
17 design differences that explain one set of values from
18 the other set of values.

19 If you can't explain it because of a
20 design difference or because of a performance
21 difference, what's left is a modeling difference.

22 CHAIRMAN APOSTOLAKIS: Very interesting,
23 very interesting.

24 MR. DUBE: This was done for all of the
25 components for all of the systems installed in the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MSPI, and then the Westinghouse owners group even went
2 further. They looked, and we talked about changes
3 like VOS-VOS like power frequency, and there they
4 found it was a pretty tight distribution for a plant.

5 They also looked at small LOCA frequency,
6 which varied significantly. They looked at
7 conditional core damage probability, a contribution to
8 core damage frequency from lots of service water, and
9 according to their grouping, compared the results
10 from --

11 CHAIRMAN APOSTOLAKIS: So, Don, you expect
12 the industry to do this for all components?

13 MR. DUBE: All the MSPI in scope
14 components.

15 CHAIRMAN APOSTOLAKIS: How many?

16 MR. DUBE: Primarily pumps and diesels.

17 CHAIRMAN APOSTOLAKIS: So how many of
18 those are we talking?

19 MR. DUBE: Three thousand components.

20 MR. CHEOK: Now, remember we didn't expect
21 them to do it. They proposed that they would do it in
22 place of the two requirements we showed you.

23 CHAIRMAN APOSTOLAKIS: So 3,000 pictures
24 like this is preferable than doing little B?

25 MR. DUBE: No, not 3,000 pictures. I

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 mean, this is two times. This is already what, a
2 couple hundred or a hundred, a couple hundred right
3 here. So it's not 3,000.

4 CHAIRMAN APOSTOLAKIS: Well, I mean, 3,000
5 divided by --

6 MR. DUBE: Yeah.

7 CHAIRMAN APOSTOLAKIS: That's interesting.

8 MR. DUBE: Well, so we --

9 CHAIRMAN APOSTOLAKIS: But the important
10 point here other vendor groups will do the same thing.

11 MR. DUBE: These are group groups that are
12 similar. B&W, since they're a small population it's
13 hard to get --

14 CHAIRMAN APOSTOLAKIS: Yeah, but it's
15 interesting that this is done by the owners group,
16 right?

17 MR. DUBE: Right.

18 CHAIRMAN APOSTOLAKIS: Not by individual
19 utilities.

20 MR. DUBE: We derived our own set of
21 groups, and we actually for the six systems in the
22 MSPI developed about 30-something groups.

23 The next shows one example of a group.
24 Now, this is actually a histogram fitted with a curved
25 fit to it because we had groups, cases we were

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 overlapping four or five histograms at a time, and the
2 typical histogram bar chart doesn't show up very well
3 when you overlap it.

4 Really what this is is this point right
5 here, for example, means that there are, in the
6 industry, there are 55 diesel generators -- oh, by the
7 way, this is from the category of diesel generators
8 that are really more than two but less than or equal
9 to three. So what that means is three diesel
10 generator plants and kind of two and a half diesel
11 generator plants.

12 So how can you ever have a diesel
13 generator, but there might be a shared diesel between
14 two units, and so we counted that as a half. It might
15 have been a station blackout. It may have been, you
16 know, a non-safety related, small diesel generator
17 that provided limited AC power.

18 So we had a routine to do it, but
19 basically it's three diesel generator plants is
20 another way to look at it.

21 So this means that there are 55 diesel
22 generators in this grouping with Birnbaum values
23 between ten to the minus six and ten to the minus
24 five, and you can go through that.

25 The blue is the industry distribution.

1 The pink is the SPAR distribution, and what this shows
2 is for -- well, this graph says a lot of things, but
3 just the shape of the graph says a lot of things.

4 The fact that the SPAR and the industry
5 overlap says there's pretty darn good agreement on the
6 Birnbaum values, and if you look at what is behind the
7 Birnbaum value, what determines the Birnbaum value is
8 a loss of off-site power frequency, the nonrecovery of
9 off-site power and probability, the reliability of
10 diesel generators, and equipment that you use to
11 mitigate a station blackout, such as a steam driven
12 pump.

13 This tells us that at least for this
14 category of plants, there's pretty darn good agreement
15 in the overall Birnbaum values, at least on the whole
16 or the population as a whole for this group.

17 The width of the curve tells us a lot of
18 things, too, because the fact that the widths are
19 about the same tells u we have about the same
20 variability, and since the SPAR only has design
21 variability and the industry may have design and data
22 and model variability. That kind of tells us that the
23 way everybody is modeling loss of off-site power and
24 station blackout kinds of sequences and the kinds of
25 loss of off-site power frequencies that are being used

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 and the kinds of diesel generator unreliabilities are
2 probably not all that far different.

3 CHAIRMAN APOSTOLAKIS: Well, unless you
4 look at the range, which is from ten to the minus
5 seven to ten to the minus three.

6 MR. DUBE: Yeah, but then --

7 CHAIRMAN APOSTOLAKIS: Well, that's kind
8 of different, Don.

9 MR. DUBE: But then you look at those and
10 you say why is that, and it's probably because sine
11 the SPAR value has moved out, differences in data and
12 differences in modeling method, this tells you that
13 there are probably still differences in design
14 capability between a value here and a value here, when
15 you find such things as I mentioned before, additional
16 mitigation strategies for loss of off-site power or
17 station blackout.

18 CHAIRMAN APOSTOLAKIS: Oh, I would say
19 that it's a combination of all the things you
20 mentioned. I don't know how you can conclude that
21 everyone models it more or less the same.

22 It could be modeling differences. It
23 could be design differences, right?

24 MR. DUBE: But not in the SPAR because the
25 SPAR is using --

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Not in the SPAR.

2 MR. DUBE: -- the same modeling and the
3 same overall generic data. So what can explain a
4 plant here, a diesel generator here and a diesel
5 generator here is it's involved. There are still
6 additional design differences between three diesel
7 plants that account for several orders of magnitude
8 and susceptibility to a loss of off-site power event.

9 And you'll find that there are some two or
10 three diesel plants where you have a loss of off-site
11 power and failure of the diesels. You have limited
12 battery capacity, limited steam drive aux. feed pumps,
13 and the conditional probability of core damage is
14 relatively high, whereas others, you still have three
15 diesels, but they may have a number of mitigation
16 features. You know, all it takes is one or two.
17 Given a station blackout, it only takes one or two
18 mitigation features to reduce the susceptibility by
19 one or two or three orders of magnitude.

20 DR. KRESS: I think George's -- correct me
21 if I'm wrong -- point was that the blue curve, if
22 there are three different things that influence its
23 position, shape, and location, some of those could be
24 pluses and some of them could be minuses, and you end
25 up by coincidence being that close together.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: That could be, too.

2 MR. DUBE: Could be.

3 CHAIRMAN APOSTOLAKIS: Could be. Don
4 doesn't believe it though.

5 MR. DUBE: yeah. I believe it can be a
6 combination, but --

7 CHAIRMAN APOSTOLAKIS: But also this
8 supports, I think, very strongly what I said earlier,
9 not because I said it; because it's a widely held
10 belief that the PRAs really should be plant specific.

11 MR. DUBE: Should be what?

12 CHAIRMAN APOSTOLAKIS: Plant specific.

13 DR. KRESS: Yeah, that really supports
14 that.

15 CHAIRMAN APOSTOLAKIS: This really
16 supports that statement, right? I mean, if you have
17 a plant where the band bone (phonetic) is on the order
18 of ten to the minus six and another one close to ten
19 to the minus four, as you said, there are real
20 differences.

21 It can't be just analysis, and if I do a
22 generic PRA, I'll probably be either unfair or you
23 know.

24 DR. KRESS: You'll be unfair to some of
25 them, yeah.

1 CHAIRMAN APOSTOLAKIS: So don't you agree,
2 Don, that they should be plant specific?

3 MR. DUBE: Yeah, I come from that school
4 to begin with, but --

5 CHAIRMAN APOSTOLAKIS: But you are trying
6 to liberate yourself?

7 (Laughter.)

8 MR. DUBE: No, I think the SPAR has --

9 CHAIRMAN APOSTOLAKIS: Look at what the
10 SPAR shows then.

11 MR. DUBE: -- has allowed us -- this
12 comparison allowed us to rule out two out of the
13 three --

14 CHAIRMAN APOSTOLAKIS: I understand that.

15 MR. DUBE: -- causes of variability.

16 CHAIRMAN APOSTOLAKIS: But even the SPAR
17 variability is due to design features, right?

18 MR. DUBE: That's definitely true.

19 MR. CHEOK: That's correct.

20 CHAIRMAN APOSTOLAKIS: Therefore, the PRA
21 should -- plant specific means, you know, not just the
22 data. The whole thing. It's a very strong statement
23 support --

24 MR. DENNING: The structure is plant
25 specific. The structure that they're doing is plant

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 specific. It's the data --

2 CHAIRMAN APOSTOLAKIS: I am not implying
3 any criticism.

4 MR. DENNING: I mean we come back again
5 and again to what is really an important issue and one
6 that --

7 CHAIRMAN APOSTOLAKIS: It is a very
8 important issue.

9 MR. DENNING: -- we're going to debate for
10 quite a while.

11 CHAIRMAN APOSTOLAKIS: It's very important
12 issue, but this is really a nice figure.

13 MR. DUBE: Now, we were in a situation
14 where we couldn't go through and review the modeling
15 structure and data behind some 3,000 components that
16 are within the scope of the MSPI. So we had a process
17 to identify significant differences, and I'm not going
18 to dwell on it, but here is a case where we identified
19 a candidate outlier where I call it Plan B, had a
20 Birnbaum value. This is the industry value. I show
21 a vertical line, but it's basically around ten to the
22 minus sixish.

23 CHAIRMAN APOSTOLAKIS: Would I care about
24 that? Why would I care about that? That's a pretty
25 good plant or am I missing.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: The SPAR value said it was --

2 CHAIRMAN APOSTOLAKIS: Oh, it's for the
3 same plant.

4 MR. DUBE: Oh, yeah.

5 CHAIRMAN APOSTOLAKIS: Oh, okay, okay.

6 MR. DUBE: -- three times ten to the minus
7 five.

8 DR. KRESS: That one you should worry
9 about.

10 MR. DUBE: So now we had a process where
11 we looked at significant differences between plant
12 specific values within a particular group. So we
13 started by grouping them and say they have this
14 feature of three diesel generators, but within the
15 group, why would the plant be here and why would the
16 SPAR say it's here?

17 And that --

18 CHAIRMAN APOSTOLAKIS: Aren't you
19 duplicating what Bob showed us? I mean he showed a
20 straight line, and he took the Birnbaum from SPAR,
21 Birnbaum from the utility, and if it's way below the
22 line, he does something about it.

23 MR. DUBE: It is similar. It's similar.

24 CHAIRMAN APOSTOLAKIS: They're the same.
25 You're just showing it in a different way.

1 MR. DUBE: Whereas you're developing it on
2 a systematic process for --

3 CHAIRMAN APOSTOLAKIS: You are not
4 systematic.

5 (Laughter.)

6 MR. DUBE: -- long term over several
7 years, by the time we received the data, we had
8 basically three months to input the data, do this
9 comparison, identify candidate outliers --

10 CHAIRMAN APOSTOLAKIS: But it's the same
11 thing essentially though, and go through from 200 --
12 yeah. I mean, in the end we had 260-such cases where
13 there was a significant --

14 CHAIRMAN APOSTOLAKIS: Really? That many?
15 Two hundred sixty cases of this component?

16 MR. DUBE: Of significance variance
17 between the licensee's value and the SPAR. And then
18 we have to dig in and identify one of three things.
19 Is it SPAR anomaly, a licensee anomaly? Is there a
20 real design difference? Is there a modeling
21 difference? Is it a data difference?

22 CHAIRMAN APOSTOLAKIS: And what were the
23 insights that you drew from this?

24 MR. DUBE: That's coming up in two slides
25 -- three slides.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Can I wait for
2 three slides?

3 MR. DUBE: Now, here's a case where we
4 showed the distributions for RHR pumps for a two-pump
5 system with a high pressure recirc. booster pump.
6 What that means is for many Westinghouse plants and
7 some B&W plants, in a high pressure recirculation
8 mode, they have a piggyback mode where a low pressure
9 pump draws from the containment sump and provides
10 suction to a high pressure and safety injection pump,
11 which then injects them to the core.

12 So for that class of plants with that
13 capability.

14 MR. DENNING: And it's a subset of the
15 figured that we saw before.

16 MR. DUBE: No, this is a whole -- this is
17 for RHR folks.

18 MR. DENNING: Oh, I'm sorry. I'm sorry.
19 Absolutely. I Understand.

20 MR. DUBE: This is one of 30 groups. Now
21 what you see here, remember the size and shape of the
22 curve. I mean, this is just for graphical aid, but it
23 shows here the blue curve is the industry
24 distribution. The pink is the spine distribution.
25 You see an offset between the two.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 And now you have to ask yourself why is
2 there an offset. Why does there appear to be a bias
3 in one or the other? And you have to ask yourself did
4 the utilities for 103 plants all congregate together
5 and systematically bias their values, and in this case
6 to the high side. So why would they do that, or is
7 there something in the SPAR model that seems to
8 systematically bias it to the low side compared to the
9 licensee's PRA models?

10 And you say, well, it's probably more
11 likely the latter since it's using standard method,
12 standard models, standard data. And when you dig into
13 this particular case, you find that the licensees --
14 you know, this is driven for sequences of small LOCA
15 where you rely on high pressure recirculation. So
16 when you dig in a little bit deeper, you'll find that
17 the licensees did use a distribution of small LOCA
18 frequencies. In fact, it was quite wide.

19 But the SPAR models use a small LOCA
20 frequency significantly lower than what the industry
21 was using. In fact, the small LOCA frequency here was
22 almost an order of magnitude lower than the average in
23 the industry used, which because the dominant cut sets
24 are small LOCA and failure of high pressure recirc.
25 and so on and so forth, systematically bias the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 Birnbaum values for these RHR motor driven pumps to
2 the point that it shifts in the curve to the left, and
3 when you dig into it, you find that the small LOCA
4 frequency in the SPAR models for 4E to minus four,
5 whereas most industry values use two or 3E to minus
6 three, like a factor of --

7 CHAIRMAN APOSTOLAKIS: What is the reason
8 SPAR used such a lower number?

9 MR. DUBE: The gentleman here might
10 answer, but you know, when you looked into it, it's
11 because of a different definition of small LOCA. This
12 small LOCA is kind of considered the high end of the
13 small LOCA pipe breaks, whereas many of the industry
14 values included historical stop open relief valves and
15 reactor coolant pump, mechanical seal failures, and
16 the 400 and 500 gallon a minute kinds of leaks,
17 whereas this was predominantly a pipe break, which
18 could be several thousand gallons a minute, and I
19 think that's what it is.

20 I mean, it's something we'll have to look
21 into.

22 CHAIRMAN APOSTOLAKIS: So did the SPAR
23 people change their frequency?

24 MR. DUBE: I don't know because I just saw
25 this graph.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 (Laughter.)

2 CHAIRMAN APOSTOLAKIS: So it's somebody
3 else's graph?

4 MR. CHEOK: This MSPI comparison is
5 ongoing as we speak and --

6 CHAIRMAN APOSTOLAKIS: This is not MSPI
7 now. This is Birnbaum.

8 MR. CHEOK: That's right, but it
9 becomes -- Don is going to pass this over to the SPAR
10 model development people, and we're going to use these
11 crash to help us as another QA tool, so to speak.
12 That's why we thought this was an interesting thing.

13 CHAIRMAN APOSTOLAKIS: So we are seeing
14 the relations here.

15 MR. CHEOK: Right, correct.

16 MR. DUBE: This is hot off the press.

17 But these vertical lines show that while
18 the absolute values of the Birnbaums used by SPAR and
19 industry were pretty much the same, it showed that the
20 industry value was right at the median or mode, pretty
21 much the median, whereas the SPAR value was to the
22 high side.

23 So this would be another candidate outlier
24 because if you correct for the fact that the SPAR is
25 using appears to be a low loss of small LOCA

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 frequency, the industry is an outlier because to
2 correct for that, the SPAR Birnbaum is to the high
3 side in the industry, is in the norm.

4 So based on our criteria and screening,
5 this might have been caught. We would have taken a
6 look at that, notwithstanding the bias introduced by,
7 you know, what appeared to be a systematic small LOCA
8 frequency.

9 MR. CHEOK: Now, this is a class case if
10 you just looked at the Birnbaums from both the
11 industry and the SPAR for a particular plant. You
12 would think that they are almost exactly the same, and
13 you would think that there would be no bias, but we're
14 thinking that it actually could be different because
15 the industry distributions are shifted, which makes
16 this the plant specific values are biased.

17 MR. DUBE: This is not just a visual tool
18 to aid us in identifying outliers and out of the 3,000
19 or so components we started with -- we screened that
20 down to 260-something, and then myself, Peter
21 Appignani, Jim Vail, and other contractors, some SRAs
22 from the regions went through all 260 one at a time to
23 disposition them and identify is it a real design
24 difference. Is it a SPAR modeling issue? Is it a
25 licensee's modeling issue?

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 DR. THADANI: Don, if I may just make a
2 quick comment on back to what George said. The
3 earlier slide when you talked about modeling of the
4 sump issue, you had four times ten to the minus six
5 increase in core damage frequency using SPAR model for
6 small LOCA. If you had increased this by an order of
7 magnitude, you would presumably get four times ten to
8 the minus five.

9 CHAIRMAN APOSTOLAKIS: I thought it was
10 large LOCA, Ashok.

11 DR. THADANI: Pardon me?

12 CHAIRMAN APOSTOLAKIS: I thought what they
13 showed earlier was for large LOCA.

14 DR. THADANI: Three, three. No, they
15 showed for large LOCA, medium LOCA and small LOCA, and
16 I'm saying small LOCA contribution would have been
17 four times ten to the minus five then if you follow.

18 MR. DUBE: But maybe not because it would
19 have been the small LOCA from pipe breaks, which would
20 loosen up the insulation, where if you add relief
21 valves that dump into a quench tank for RCP seal, they
22 may not have generated the debris. So --

23 DR. THADANI: They're safety valves also,
24 but anyway.

25 MR. DUBE: So we summarize the licensee's

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 PRA issues into the following. After going through
2 260-odd candidates and narrowing it down, what did we
3 find?

4 Well, some of these aren't quite candidate
5 allied issues, but we had situations where open A and
6 B facts and observations could possibly affect the
7 MSPI, and we're holding these issues open until the
8 licensees address them. We found 16 cases of that out
9 of the hundred or so plants out there.

10 Model truncation and convergence issues,
11 14. What --

12 CHAIRMAN APOSTOLAKIS: Model truncation,
13 you mean the cutoff frequency?

14 MR. DUBE: What we found is that a number
15 of licensees could not lower their truncation value on
16 their PRA quantification enough to insure that the
17 model was --

18 CHAIRMAN APOSTOLAKIS: What's "enough"?
19 Ten to the minus 12?

20 MR. DUBE: Well, some of them were using
21 ten to the minus nine and ten to the minus ten.

22 CHAIRMAN APOSTOLAKIS: But it's not a
23 sufficient cut of leverage, ten to the minus 12, I
24 think.

25 MR. DUBE: But they couldn't get low

1 enough.

2 CHAIRMAN APOSTOLAKIS: Right. Isn't that
3 what you guys told us?

4 DR. BUELL: We used ten to the minus 12,
5 is what we used.

6 CHAIRMAN APOSTOLAKIS: So it just be
7 sufficient.

8 (Laughter.)

9 CHAIRMAN APOSTOLAKIS: Boy, you guys are
10 so modest today.

11 MR. DUBE: In some cases the model is so
12 complex that the software just didn't accommodate
13 going lower and lower. So they could not assure that
14 the CDF was converged and that the Birnbaums were
15 convergent, and usually you have to go even lower to
16 converge importance (phonetic) measures like Fussell-
17 Vesely and Birnbaum than you do to converge a core
18 damage frequency.

19 CHAIRMAN APOSTOLAKIS: Now, the Birnbaum
20 measure is related to the risk achievement worth, is
21 it not?

22 MR. DUBE: Yeah, and it's proportional to
23 the Fussell-Vesely, too.

24 CHAIRMAN APOSTOLAKIS: How can that be?
25 Fussell-Vesely is a separate, different model.

1 MR. DUBE: I can show you algebraicly that
2 they're --

3 CHAIRMAN APOSTOLAKIS: Are you saying that
4 Fussell-Vesely and RAW are related?

5 MR. DUBE: Yes.

6 CHAIRMAN APOSTOLAKIS: No, they're not.

7 MR. DUBE: Yes.

8 CHAIRMAN APOSTOLAKIS: Let's go back then
9 to the graded quality assurance and all that stuff.
10 They're supposed to be independent. I mean they're
11 related because they're referring to the same PRA.

12 MR. DUBE: Algebraicly the Birnbaum is
13 equal to the Fussell-Vesely divided by the failure
14 probability of the basic event, failure probability
15 times the core damage frequency.

16 CHAIRMAN APOSTOLAKIS: And the Birnbaum is
17 the core damage frequency times RAW, right? No? Oh,
18 no, because it's a difference, but it must be related.
19 Come on. It's one minus the RAW or something like
20 that or RAW minus one.

21 DR. KRESS: You've got to have a two in
22 there.

23 MR. DUBE: It's approximately equal to one
24 plus Fussell-Vesely over P.

25 CHAIRMAN APOSTOLAKIS: No. Where P is

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 what?

2 MR. DUBE: Failure probability.

3 CHAIRMAN APOSTOLAKIS: No. Can't be. RAW
4 and Fussell-Vesely are not related at all. Maybe
5 you're confusing it with the risk reduction worth.
6 That's related to Fussell-Vesely. Risk reduction
7 worth is --

8 MR. DUBE: I'll show you the derivation.

9 CHAIRMAN APOSTOLAKIS: Oh, my God, yes.
10 I do want to see. It can't be true.

11 MR. DUBE: Loss of off-site power
12 frequency showed up in nine, and this is, as I
13 mentioned, we found a -- generally the licensee's loss
14 of off-site power frequency has agreed very much with
15 the SPAR and within themselves, but we found cases
16 where the loss of off-site power frequency were
17 factors of three, four, and five lower than what you
18 would expect, even one case where the licensee's plant
19 was in the middle of the northeast blackout, and yet
20 their loss of off-site power frequency is still an
21 order of magnitude lower than --

22 CHAIRMAN APOSTOLAKIS: What is it that
23 makes them an issue, these? Because they disagree
24 with SPAR?

25 DR. KRESS: They become an outlier.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: We could not explain it, and it
2 was at first cut an outlier because it was not a bona
3 fide design difference. It was the use of an
4 initiating frequency or a failure probability or a
5 modeling issue that was I guess you would say outside
6 the norm.

7 CHAIRMAN APOSTOLAKIS: Well, that was
8 based strictly on the industry developed code, not the
9 SPAR.

10 MR. DUBE: We used the SPAR curve and the
11 industry curve to provide us a screening criteria for
12 first identifying differences at a high level, and
13 then we dug down into the issue to identify why is
14 there a difference, and in these cases we would find
15 that the licensee used -- the reason why the Birnbaum
16 is different by an order of magnitude is because the
17 licensee's losses of off-site power frequency is an
18 order of magnitude lower than the norm.

19 CHAIRMAN APOSTOLAKIS: But you didn't
20 compare a high percentile of the blue curve with a low
21 percentile of the blue curve and try to figure out
22 what is the difference.

23 MR. DUBE: No.

24 CHAIRMAN APOSTOLAKIS: It was between
25 industry and SPAR.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 MR. DUBE: Right. That was just our
2 starting point.

3 CHAIRMAN APOSTOLAKIS: Okay, all right.

4 MR. DUBE: Low loss of service water
5 frequency issues, here we even saw greater
6 variability, and Bob alluded to it, but we saw cases
7 where the experience base loss of service water
8 frequencies like 4E to the minus four. Yet there were
9 some licensees one, two in one case, one almost three
10 orders of magnitude lower than that. They were in the
11 realm of below ten to the minus six per year, which
12 was once in every million years.

13 DR. KRESS: Yeah, that's never.

14 MR. DUBE: It just stood up. I mean, it
15 just doesn't pass the standard.

16 And these issues were found by doing these
17 kinds of screenings and zeroing in on what the
18 difference is.

19 This has to do -- and I won't get into too
20 much detail -- is that as Bob mentioned, if you don't
21 have a support system, initiate a fault tree like a
22 loss of service water fault tree. You could
23 underestimate the Fussell-Vesely contribution. So
24 there are five instances of that.

25 Here, Bob mentioned this as well. The

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 licensees took credit for reactor pressure vessel
2 injection after containment. Now, it's possible that
3 these might get resolved. At the time that we had to
4 generate the summary list we had not yet received
5 analysis and justification for that.

6 DR. KRESS: Now, do some of these plants
7 show up in more than one of these?

8 MR. DUBE: Yes. Yes, some of them show up
9 in at least -- I've seen some in at least three of
10 systems or three -- I mean, if you add them all up,
11 it's less than one issue per plant, which isn't too
12 bad. That tells you a lot right there.

13 Station blackout mitigation strategies
14 having to do with the way they might have modeled
15 recovery of off-site power, the way they may have
16 taken credit for mitigation strategies, some AC
17 dependent pump, for example.

18 Off-site power recovery issues, Bob
19 mentioned this, taking credit for operating circuit
20 breakers which are DC powered after battery depletion.
21 It's kind of a catch-all and explains --

22 CHAIRMAN APOSTOLAKIS: Well, that doesn't
23 -- I mean, it was explained to us earlier that the
24 time to core uncover after you lose complete power is
25 not included in SPAR. So that may have something to

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 do with it, too.

2 MR. DUBE: It could. For example, one
3 licensee said that their procedure would be something
4 along the lines of if they're running out of battery
5 power and they're operating a turbine driven aux. feed
6 pump, it would be to run it full out, fill the steam
7 generators all the way to the top before they run out
8 of battery power to control the turbine.

9 And if you consider decay heat in eight or
10 ten hours into an event, that buys them a lot of time
11 before you dry out the steam generators, given that
12 time. So there are some issues like that.

13 This is kind of related, control of
14 turbine driven power. One case of a low line to DC
15 bus initiator frequency, and missing test and
16 maintenance on a basic event diesel generator.

17 So this is our list of PRA issues that we
18 developed focusing just on MSPI specific components
19 and trying to understand the reasons for the
20 differences.

21 Any questions on this?

22 And then the final one is a summary of the
23 generic FAR issues, and most of these have already
24 been covered by Bob and John, but I'll just summarize
25 them. We did find, but we appear to have

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 introduced -- remember that curve where I showed a
2 bias where this appears to be possibly because of a
3 low small LOCA frequency. We found a case of an
4 opposite bias in the other direction because of what
5 appears to be a high loss of emergency AC bus
6 initiator frequency, which appears to be an order of
7 magnitude higher than all the industry values.

8 I'm not quite sure why. It could be
9 having to do with the counting of the number of buses
10 that could possibly be affected. It could be a number
11 of reasons that may not account for recovery.

12 It looks like the emergency AC bus
13 initiator frequency in SPAR is representative of a
14 spurious opening of a circuit breaker, whereas the
15 industry values tend to be more bus fault failure
16 rate, which is generally an order of magnitude lower,
17 and that might account for the differences there.

18 But there is a difference of
19 systematically of about an order of magnitude.

20 Bob mentioned the pressurizer PORV success
21 criteria. I kind of differ a little bit. I kind of
22 have a different perspective because, you know, I did
23 manage best estimate LOCA success criteria for two
24 PRAs, Connecticut Yankee and Millstone 2, and we did
25 multi-man-year RELAP 5 analyses to develop success

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 criteria for feed and bleed, and we saw that it can
2 vary. You know, it's a function of the pressurize of
3 PORV relief capacity, the thermal power, whether one
4 had relatively low head-high head safety injection
5 forms like a CE plant may have only 1,200 psi shutoff
6 safety injection pumps, where many Westinghouse plants
7 have high capacity, high shutoff charge pumps.

8 And we found differences that can be plant
9 to plant variation in success criteria. It is
10 possible to feed and bleed with one PORV in some
11 plants. In other plants it might require two PORVs
12 just because of the relief capacity and the
13 differences in high head safety injection.

14 And we saw differences there between SPAR
15 and licensees. So in a couple of cases we asked the
16 licensees to provide us information, and Duke Power
17 sent us a 1,000 page calculation of RELAP 5 where they
18 showed two PORVs would be successful, and under a
19 number of circumstances one PORV would be successful
20 as well.

21 So I think the jury is still out, and it's
22 a good opportunity here for additional research into
23 the success criteria.

24 DR. THADANI: But, Don, on the B&W I
25 thought there was only a one inch PORV in B&W plants

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 so that they have very limited capacity, don't they?

2 MR. DUBE: B&W, we saw a difference. We
3 saw cases with one and some cases with two PORVs
4 successful.

5 DR. BONACA: It also depends, as we were
6 discussing before, on the entry time. I mean, it
7 depends on a number of parameters.

8 MR. DUBE: Yes.

9 DR. BONACA: For some plants like the C
10 plants, I mean, they have the PORVs. They're
11 successful in fitting only if you can fit early
12 enough.

13 MR. DUBE: Yeah, that's an important
14 criteria which is how early do you attempt to feed and
15 bleed because what tends to happen is when you lose
16 your decay heat and pressurize, the pressure goes up,
17 and you can open a PORV, and if it can't relieve
18 capacity, the pressure keeps rising, and it goes above
19 the shutoff of the safety ejection pumps and it will
20 never turn around.

21 That's why a CE plant with 1,200 PSI HPCI
22 pumps and very low capacity charging pumps, timing is
23 everything. You take it early enough and if you also
24 use the steam generator atmospheric dump valve, you
25 can crash the RCS pressure to a low enough pressure

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that the safety injection pumps start injecting, and
2 then they start injecting cold water, and you get a
3 positive feedback situation where injecting cold water
4 further cools you down, which further depressurizes,
5 which gives you more cooling water, which further
6 depressurizes you and cools you down, and you can
7 self-sustain that.

8 Whereas Westinghouse plants with high head
9 shiving (phonetic) pumps with 2,300, 2,400 PSI cutoff
10 aren't as sensitive to that because if you open a
11 PORV, you get the pressure down and then can inject
12 almost enough flow to meet decay heat at the PORV's
13 shutoff, and so you tend to find that C plants are
14 more likely to have two PORV success criteria whereas
15 many Westinghouse plants with high head charging pumps
16 could possibly do it with one PORV.

17 All right. So enough of that issue. We
18 did find modeling asymmetries. We're in some of the
19 earlier SPAR models they modeled only loss of DC power
20 on one bus and not the other bus, and that cause
21 asymmetry in the Birnbaum values. I think that has
22 since been corrected, but at least the models that we
23 use, that accounted for a significant number of
24 variation.

25 Bob mentioned the single value loss of

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 service water frequency. I think that's an issue.
2 Whereas, you know, there are plant-to-plant
3 differences and we saw cases in the industry values
4 where they had bona fide design reasons, site reasons
5 why one could account for differences in loss of
6 service water frequency, and maybe an order of
7 magnitude, you know, or one and a half orders of
8 magnitude could account for that.

9 I'm not quite sure, and I don't personally
10 believe three orders of magnitude differences in loss
11 of service water frequency.

12 But we found a couple of cases of higher
13 failure probability for local manual control of
14 turbine driven aux. feed pumps, whereas the licensee
15 had provided us an approved procedure and a training
16 program where they routinely train on this process.
17 They might justify a lower human error probability
18 that's in the SPAR model, for example.

19 At least back in the spring when we
20 collected the data, some of the B&W plants had old
21 sealed LOCA models. This has since been corrected in
22 the last month, but you know, that did account for
23 some of the differences in the SPAR model.

24 I mention the small LOCA frequency. In
25 several instances where the SPAR did not model test

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 and maintenance for some point performance.

2 I mentioned most of these issues are being
3 addressed, but you know, we kind of independently
4 verified a lot of this.

5 So where am I? I guess summary is the
6 process we used was narrowly focused on some 3,000,
7 5,000 components within scope of the MSPI. It was a
8 three-month focused effort on understanding the
9 differences between the SPAR values and the industry
10 values, trying to disposition the differences as being
11 a bona fide design difference, data difference or
12 modeling differences, and where it appeared to be a
13 licensee modeling issue, it's an issue that we've put
14 on the table for requesting the licensee to provide
15 further justification before we disposition it or it
16 may not be dispositioned.

17 CHAIRMAN APOSTOLAKIS: You're done?

18 MR. DUBE: Yes.

19 CHAIRMAN APOSTOLAKIS: Can you remind me
20 what the MSPI is used for?

21 MR. DUBE: It's a performance indicator
22 for measuring the performance of six systems.

23 CHAIRMAN APOSTOLAKIS: It's replacing
24 which performance?

25 MR. DUBE: Safety system unavailability.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: Okay.

2 MR. DUBE: It's strictly unavailability.

3 CHAIRMAN APOSTOLAKIS: So it includes the
4 reliability over a period of time.

5 MR. DUBE: Right, right.

6 CHAIRMAN APOSTOLAKIS: Very nice.

7 Any questions to Don from the members?

8 (No response.)

9 CHAIRMAN APOSTOLAKIS: Thank you very
10 much.

11 DR. THADANI: Outstanding work.

12 CHAIRMAN APOSTOLAKIS: As Dr. Thadani
13 noticed, expressing a personal view.

14 (Laughter.)

15 DR. KRESS: Not necessarily that of the
16 committee?

17 CHAIRMAN APOSTOLAKIS: Because the
18 committee will -- what will the committee do?

19 DR. KRESS: We don't. We just make
20 recommendations and comments.

21 CHAIRMAN APOSTOLAKIS: Yeah.

22 DR. KRESS: To the full committee.

23 CHAIRMAN APOSTOLAKIS: For deliberation by
24 the full committee.

25 DR. KRESS: Yeah. That might very well be

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 something we'll say.

2 CHAIRMAN APOSTOLAKIS: But did Dr. Dube
3 speak with sufficient clarity and volume?

4 DR. KRESS: The clarity was good. The
5 volume was --

6 CHAIRMAN APOSTOLAKIS: The volume was kind
7 of low.

8 Oh, my God, you guys again. Alone this
9 time, John?

10 DR. SCHROEDER: I think he's got
11 laryngitis by now.

12 CHAIRMAN APOSTOLAKIS: How much time do
13 you need?

14 DR. SCHROEDER: Well, I don't have a lot
15 to say about this particular subject.

16 CHAIRMAN APOSTOLAKIS: Wow. You know we
17 have a lot to say about this particular subject.

18 DR. SCHROEDER: I understand that.

19 CHAIRMAN APOSTOLAKIS: Go ahead. Thank
20 you.

21 DR. SCHROEDER: In the next few slides,
22 I'll try to tell you where we're at with respect to
23 modeling uncertainty in the SPAR model program.

24 As in any other PRA, we try to account for
25 both data uncertainty and modeling uncertainty.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 However, our quantification code gives us the tools to
2 deal with data uncertainty fairly easily and modeling
3 uncertainty is still very hard.

4 The data uncertainty I think we have
5 fairly well in hand. We have a standard template list
6 that gives us our failure rates and tries to model the
7 failure rates with appropriate uncertainty
8 distributions.

9 The uncertainty distributions these days
10 are largely gamma functions for rate related
11 parameters and beta distributions for the demand
12 related items. Human error probabilities are largely
13 the constrained, noninformative prior type
14 distribution.

15 Now, there are other data uncertainty
16 items within the SPAR models that we are capable of
17 dealing with. The initiating event frequencies, the
18 component failure rates, and a few other things are
19 coming from the data template set that is being
20 developed for us and that there's going to be a NUREG
21 issued on.

22 A couple of other items. The off-site
23 power recovery, the diesel generator recovery failure
24 distributions are a little harder to calculate
25 uncertainty distributions on. For those, the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 statisticians have provided us with uncertainty
2 distributions on the parameters for the recovery
3 curves.

4 And using the off-site power recovery
5 module, we can then propagate, in effect, the family
6 of curves through the model.

7 CHAIRMAN APOSTOLAKIS: Now, what do you
8 mean by data uncertainty? I mean, you as a SPAR
9 developer and user have these needs? Is that what you
10 mean?

11 DR. SCHROEDER: Yes.

12 CHAIRMAN APOSTOLAKIS: Because some of
13 them are model uncertainties. Some are parameter,
14 right?

15 DR. SCHROEDER: When I'm talking about
16 data uncertainty, I'm talking about failure rates and
17 the uncertainty parameters that describe them.
18 There's also --

19 CHAIRMAN APOSTOLAKIS: These are not all
20 failure rates. I mean, recovery parameters, these are
21 not a failure rate.

22 DR. SCHROEDER: The off-site power
23 recovery curves are not failure rates, but they're
24 something for which data has been collected, and there
25 is a model for the distribution, be it log normal or

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 YABLE (phonetic). I think the current generation of
2 models uses a log normal model, and when I say
3 modeling uncertainty, I'm not talking about the choice
4 of statistical model for the data value or for the
5 curve.

6 When I talk about model uncertainty, what
7 I'm talking about basically are structural issues
8 rather than choice of distribution or selection of
9 parameter to describe the distribution.

10 One more source of uncertainty that kind
11 of crosses over into model uncertainty is whether we
12 use plant specific or generic data in all of this data
13 uncertainty analysis. We don't know exactly what the
14 right approach is, and that is being studied now, and
15 I'm not sure where it's going to land.

16 It is fairly easy for us to take plant
17 specific data and plug it into these models because of
18 our generic template set, and on many failure rate
19 issues or initiating event frequency issues, plant
20 specific values are calculated, but it's sort of a
21 management decision as to whether those are
22 appropriate to use in the SPAR program.

23 I can't say much more about those items
24 than that. We can do the Monte Carlo analysis. We
25 have failure rates. We have uncertainty distributions

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 on the failure rates, and we can propagate those.
2 There will be a data report that describes those in
3 more detail.

4 CHAIRMAN APOSTOLAKIS: I mean, I do
5 appreciate the issue of structural uncertainty, but it
6 seems to me that model uncertainty where you have a
7 multiplicity of models, you guys are resolving very
8 quickly by just approving one model or taking one
9 model.

10 I mean, we like Westinghouse. We really
11 don't care about human error because we have SPAR-H,
12 and I don't know that -- I mean, I'm pretty sure that
13 a lot of that is justified, what you do, but I
14 wouldn't dismiss those uncertainties offhand.

15 You know, the structure of uncertainty is
16 extremely important, as is incompleteness, but I don't
17 know. I get the feeling that you are really
18 dismissing that.

19 MR. CHEOK: I'm not quite sure you're
20 dismissing them, George. I think we understand that
21 they are there, and I think one of the keys to
22 decision making is to know where your uncertainties
23 are and to understand that their contributions to your
24 decision is such-and-such.

25 So they're not quite dismissing them. I

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 think what you would like for us to do is to maybe
2 quantify it more.

3 CHAIRMAN APOSTOLAKIS: No, no, no.

4 MR. CHEOK: We are not, in a sense,
5 quantifying the uncertainties.

6 CHAIRMAN APOSTOLAKIS: I like the idea of
7 starting with a decision. Didn't we talk to you about
8 something we did?

9 MR. CHEOK: You might have.

10 CHAIRMAN APOSTOLAKIS: One, one, seven,
11 four, for example.

12 MR. CHEOK: That's correct.

13 CHAIRMAN APOSTOLAKIS: If the licensee
14 comes in there and says, "Look. I did my calculations
15 and this is the point on the diagram," the famous
16 diagram, and then you ask yourself, okay, they use the
17 human error probability, for example. If I change
18 that, would I affect the decision?

19 MR. CHEOK: Sure.

20 CHAIRMAN APOSTOLAKIS: And then you ask
21 the second question: is it reasonable to change it by
22 that much?

23 And I was much surprised when I saw an
24 SER, in fact, where they were reviewing one of the
25 submittals, and the licensee used the value for the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 relevant human error of .5. I don't care. If I make
2 it one, it doesn't really matter.

3 So even though there is model uncertainty
4 in the human error part --

5 MR. CHEOK: It doesn't matter.

6 CHAIRMAN APOSTOLAKIS: -- it doesn't
7 affect this decision because the licensee used the
8 high value.

9 MR. CHEOK: Absolutely.

10 CHAIRMAN APOSTOLAKIS: So it's the two
11 elements that are very important. Okay?

12 By the way, I think there are two papers.
13 There is a very interesting just one that I remember,
14 a paper by several authors from PLG, the old PLG,
15 where they documented several cases where different
16 model assumptions made a big difference to their PRA.
17 And you know those guys were doing a lot of PRAs at
18 that time. It's a 20 year old paper.

19 But you know --

20 DR. THADANI: I can give you a more recent
21 example, George, and Mike knows this very well. It's
22 the steam generator tube failure event at Indian
23 Point. When you brought and model uncertainty, and
24 this analysis was done, redone, to fold in some
25 uncertainties, particularly human reliability model

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 that was used, you came to different plausible
2 conclusions about that event and whether it was red,
3 yellow, white, you know.

4 This is a big issue, and I think, Mike,
5 you recall that. You might recall the results as I
6 do.

7 MR. CHEOK: Yes.

8 CHAIRMAN APOSTOLAKIS: No, but I think,
9 Mike, back to your point, the thinking up until
10 recently was, indeed, to do what you said, develop a
11 whole probability distribution across models, which
12 is, of course, very difficult to do, although we do
13 it. I mean, the expert opinion elicitation process
14 does that, right? For seismic or for pipe failures
15 and so on.

16 But now that we have decision rules like
17 1174, it's much easier to handle it because the first
18 thing you do is you're asking yourself how important
19 is it to the decision.

20 MR. CHEOK: Correct.

21 CHAIRMAN APOSTOLAKIS: Even if I raise it
22 to one, I move a little bit. So why should I care?

23 So I think this -- and in fact, there was
24 a paper from NEI or somebody at the recent PSA
25 conference in San Francisco, where they follow an

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 approach like that. Okay?

2 MR. CHEOK: Right. And I guess that's the
3 smart use of what we would call a sensitivity study.

4 CHAIRMAN APOSTOLAKIS: Absolutely,
5 absolutely.

6 MR. CHEOK: You're saying I'm trying to
7 bound my answer by plausible parameters, and if it
8 doesn't make a difference to my decision, then this
9 parameter is not important.

10 CHAIRMAN APOSTOLAKIS: It's a decision
11 focused or decision centric approach because
12 ultimately what matters is the decision.

13 MR. CHEOK: Right.

14 CHAIRMAN APOSTOLAKIS: That's what really
15 matters. I mean, that was really an eye opener. When
16 I looked at that and the guy said we put a probability
17 of .5, I said there goes the issue then. Who cares?
18 If they had put ten to the minus three
19 though, it would have been different.

20 MR. CHEOK: I think what was lost a little
21 earlier when Bob and John was showing you the caution
22 screens at the beginning of the SPAR models, one of
23 the objectives of those screens were the total user.
24 This is our assumptions, and these are the items that
25 could impact your answers if you are using the SPAR

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 models to evaluate this event and your event concerns
2 one of these issues. Then you have to be somewhat
3 careful because our models, the answers from these
4 SPAR models are somewhat sensitive to these issues.

5 CHAIRMAN APOSTOLAKIS: That would
6 certainly -- well, first of all, for them it's a
7 little difficult because they are not really dealing
8 with any decision. They're just developing a model.

9 But having something like this would be an
10 excellent starting point because ultimately what you
11 need is the decision making context, which you don't
12 have right now unless the licensee comes back to you
13 and saying, "I'm requesting, you know, to eliminate a
14 diesel," or something. So that you cannot anticipate.

15 But you can have a nice list of issues,
16 modeling issues that could, could affect the decision
17 without passing judgment on whether they do or not.

18 MR. CHEOK: Right.

19 DR. SCHROEDER: I can show you that list.

20 CHAIRMAN APOSTOLAKIS: Well, I'm sure
21 you'll have a contribution.

22 DR. SCHROEDER: If you'll allow me to,
23 I'll do it right now.

24 During the plant visits -- I need to start
25 at the beginning of this, Guy -- during the STP review

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 and during our detailed model reviews, we started to
2 see many things coming up over and over again that
3 seemed to make a big difference in our results versus
4 the licensee's results. We didn't just sit down and
5 try to guess at what the issues were. We just started
6 to keep track of the things that were causing
7 differences in the models and the things that maybe
8 were different from one licensee to the next because
9 in some cases we might think we're right and we don't
10 care what they think, but we're keeping track of the
11 issues anyway.

12 And we came up with a rather long list of
13 those issues. They're identified across the top row
14 here. Most of these are on our top ten list, but this
15 is how we got the top ten list.

16 CHAIRMAN APOSTOLAKIS: Well, that's a very
17 good start, yes.

18 DR. SCHROEDER: And it's a fairly
19 comprehensive list.

20 CHAIRMAN APOSTOLAKIS: It's wonderful. Is
21 that documented anywhere or it's still in progress?

22 DR. SCHROEDER: Well, this is done, but
23 this is in the applications now. When you go through
24 that issues list, when you log into a SPAR model and
25 you have to get through that disclaimer screen, what

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 you basically get is a summary if you are opening the
2 Calloway model. You would get a summary of that row
3 of this matrix, and these numbers in here are what we
4 described earlier, the one, two, and three.

5 They're our attempt to quantify the impact
6 of this issue on that model. In other words, it could
7 change your core damage frequency by 50 percent or 100
8 percent, and we also kept track of the particulars at
9 a given model. We have these annotations in here that
10 say, well, why did we get this result at that plant.

11 CHAIRMAN APOSTOLAKIS: No, I think this is
12 very good. If you look at, for example, the third or
13 fourth column from the right, number of calls
14 required.

15 DR. SCHROEDER: Yes.

16 CHAIRMAN APOSTOLAKIS: I would say that's
17 a structural uncertainty issue.

18 DR. SCHROEDER: Right.

19 CHAIRMAN APOSTOLAKIS: It has to do with
20 success criteria and all of that.

21 The one next to it though, no, on the
22 left, "credit for RPV injection following containment
23 failure in BWR models," you have one event now,
24 injection, right? But there may be differences of
25 opinion as to what the probability of that is. That's

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 the model uncertainty I'm referring to.

2 DR. SCHROEDER: The way it actually works
3 out in our model is that there are end states that we
4 quantify as core damage that the licensee insists are
5 okay, largely because of the --

6 CHAIRMAN APOSTOLAKIS: Oh, so it's a
7 different thing. It's still --

8 DR. SCHROEDER: It's still a structural
9 issue, success criteria issue.

10 CHAIRMAN APOSTOLAKIS: Well, then the
11 credit for recovery of off-site power is one of those.

12 DR. SCHROEDER: Yes.

13 CHAIRMAN APOSTOLAKIS: Because both of you
14 have the same event.

15 DR. SCHROEDER: Yes.

16 CHAIRMAN APOSTOLAKIS: But there is
17 disagreement as to what probability value to use.

18 DR. SCHROEDER: In particular, that's --

19 CHAIRMAN APOSTOLAKIS: That's a model
20 uncertainty.

21 DR. SCHROEDER: This first one here --

22 CHAIRMAN APOSTOLAKIS: Of one kind, of one
23 kind.

24 DR. SCHROEDER: This value K is a bright
25 illustration of that.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 CHAIRMAN APOSTOLAKIS: I think you have a
2 great starting point there to put together a nice
3 report or white paper summarizing these things in the
4 language that I'm using, and you know, for guidance in
5 the future.

6 DR. SCHROEDER: What we did is kind of
7 took an average of the values for each of these
8 columns and used that to sort of prioritize these
9 issues, and those that affected a lot of plants and
10 had the potential to change the core damage frequency
11 a lot became our top ten issues --

12 CHAIRMAN APOSTOLAKIS: Sure.

13 DR. SCHROEDER: -- that we needed to
14 address and resolve.

15 CHAIRMAN APOSTOLAKIS: That's great.

16 DR. SCHROEDER: And resolving an issue
17 doesn't mean that we will agree with the licensee on
18 it. It means that the NRC will establish a position
19 that they have strong confidence in.

20 Now, in the meantime, we have no real
21 mechanism to automate any of this in the context of
22 the SPAR model. In the HRA, we showed you how a
23 degree of belief might come into the calculation,
24 might actually be something that we could handle with
25 automation and the calculational tool.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 But these issues really at present need to
2 be handled by sensitivity or some sort of off-line
3 consideration that the analyst does when he goes to
4 draw a conclusion about whatever it is he's analyzing,
5 and that's the state of uncertainty in the SPAR model.

6 CHAIRMAN APOSTOLAKIS: There's another
7 element here that we are not including, and there's a
8 good reason for that. It's irrelevant to you. But if
9 we come back to the earlier comment about decision
10 making, you see, what matters there, again, if you go
11 to 1174, the famous diagram with the regions; what
12 matters is not just the CDF and how sensitive it is to
13 model uncertainty. It's the delta CDF, okay, because
14 many times what you find is that the CDF itself, it's
15 a little sensitive. Even if you double it, it doesn't
16 really matter.

17 But if you start doubling or tripling the
18 delta CDF, you may very well go above the line and
19 enter the forbidden region. So you need, you know,
20 both, and I think what these gentlemen are addressing
21 here is really the model uncertainties that affect the
22 CDF itself.

23 MR. CHEOK: Sure.

24 CHAIRMAN APOSTOLAKIS: And there may be
25 different sensitivities when you start talking about

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1 delta CDF.

2 MR. CHEOK: Agree. Yes, I agree with
3 that, and I guess it's actually a harder thing to deal
4 with because that is more issue specific.

5 CHAIRMAN APOSTOLAKIS: It is very issue
6 specific. That's true. That's very true.

7 Didn't we talk to you about all of this,
8 Mike, or you were not there?

9 MR. CHEOK: I as there.

10 CHAIRMAN APOSTOLAKIS: Oh, you just wiped
11 it out of your mind. It was some university people
12 talking?

13 Okay. Good. Anything else?

14 DR. SCHROEDER: Not on model and parameter
15 uncertainties.

16 CHAIRMAN APOSTOLAKIS: Okay. So what else
17 would you like to tell us?

18 DR. SCHROEDER: Well, we're really done
19 with what we had planned to present.

20 CHAIRMAN APOSTOLAKIS: Wow.

21 DR. SCHROEDER: There is a slide or two on
22 model documentation, but I don't know whether you
23 consider that valuable or not.

24 CHAIRMAN APOSTOLAKIS: Okay. Very good.
25 any questions from the members or other people

1 present?

2 (No response.)

3 CHAIRMAN APOSTOLAKIS: Well, gentlemen,
4 this has been extremely informative. Thank you very
5 much, and we'll see you again tomorrow. Is that what
6 it is?

7 DR. SCHROEDER: Yes.

8 CHAIRMAN APOSTOLAKIS: And we seem to be
9 finishing sooner than scheduled because you don't have
10 much to say, huh?

11 MR. DENNING: It's because we're so
12 cooperative.

13 CHAIRMAN APOSTOLAKIS: We're so
14 cooperative. Well, I really appreciate your coming
15 here and presenting this. This was a really good
16 piece of work, and our comments are given in the
17 spirit of being constructive, even though we may not
18 sound that way sometimes, but I think this is good.

19 MR. CHEOK: And we actually appreciate the
20 comments, especially on these issues, and tomorrow
21 when you're doing models that are kind of in the
22 formative stages, I think it's important that we get
23 your comments at this point.

24 CHAIRMAN APOSTOLAKIS: Good. No, that's
25 wonderful. That's wonderful.

1 Thank you. W. R. GROSS

2 DR. SCHROEDER: Thank you.

3 CHAIRMAN APOSTOLAKIS: And this meeting is
4 recessed.

5 (Whereupon, at 4:46 p.m., the meeting in
6 the above-entitled matter was adjourned, to reconvene
7 at 8:30 a.m., November 18, 2005.)
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

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
Reliability and Probabilistic
Risk Assessment Subcommittee

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.



William Click
Official Reporter
Neal R. Gross & Co., Inc.

NEAL R. GROSS
COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

STANDARDIZED PLANT ANALYSIS RISK (SPAR) MODEL DEVELOPMENT PROGRAM

Presentation to the Advisory Committee on Reactor
Safeguards

November 17, 2005

Nilesh Chokshi, Branch Chief
Michael Check, Assistant Branch Chief
Operating Experience Risk Analysis Branch
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research



PURPOSE OF SPAR MODEL DEVELOPMENT PROGRAM

- To provide the NRC staff with readily available and easy-to-use analytical tools for use in performing risk-informed regulatory activities.

OUTLINE OF PRESENTATION

- Overview – Nilesh Chokshi & Mike Check (RES)
- Level 1 Internal Events – Robert Buel & John Schroeder (JNL)
 - Standardized Structure
 - Model Demonstration
 - Major Modeling Assumptions
 - Modeling Issues being Addressed
 - Model and Parameter Uncertainties
 - Model Documentation
 - MSP/ Lessons-learned (7) – Don Dube (RES)
- External Events Models – Selim Sancaktar (RES)
- LERF Models – John Lehner (BNL) & Eli Goldfelz (RES)
- Low power & Shutdown Models – Jeff Mitman (RES)
- Wrap-up – Mike Check (RES)

2

Evolution of the SPAR program

- Evolved from event tree – based models used at the start of the ASP program
- Revision 2 consisted of a set of 72 event tree/fault tree linked models and subjected the models to internal and external QA review
- Revision 3 is adding support systems, more initiating events, uncertainty analysis capability and subjected the models to benchmarking against licensee PRAs
- LP/SD, external events and LERF models are currently being developed

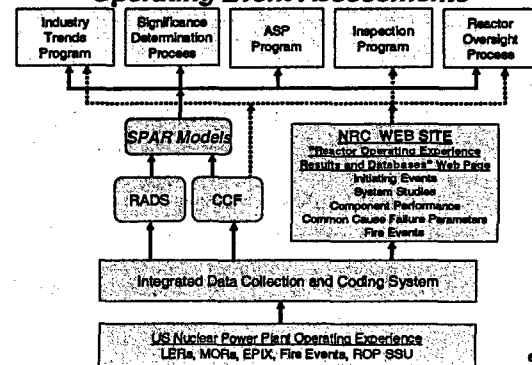
5

WHAT ARE SPAR MODELS?

- SPAR models are plant-specific PRA models that use:
 - Event trees to model accident sequence progression.
 - Fault trees to model plant systems and components.
 - Human reliability analysis (HRA) module to estimate human error probabilities.
 - Component failure and initiating event data based on national plant experience.

3

Overview: Use of SPAR Models in Operating Event Assessments



6

USES OF SPAR MODELS

- To evaluate risk significance of inspection findings in SDP Phase 3 analyses.
- To evaluate risk associated with operational events/conditions in ASP program.
- To improve the quality of PRAs.
- To perform analyses in support of GSI resolution (e.g., GSI-189 and GSI-191).
- To support staff's risk-informed review of license amendments.
- To provide independent capability to evaluate risk issues across the population of plants (e.g., verify MSP; LOOP/SBO study).

7

SPAR MODEL DEVELOPMENT PROGRAM ACTIVITIES (Continued)

- Level 2/Large Early Release Frequency (LERF):
 - 3 models (PWR w/large dry containment, BWR Mark I & PWR Ice Condenser) completed.
 - Models for 10 lead plants by 2008.
- External Events (Fires, Floods, Seismic events):
 - Six models have been created by NRR/RES team.
 - Continuing to refine model development process.

10

AGENCY INTERFACES

- SPAR Model Users Group (SMUG) organized in 1999 – Members from NRR, RES, Regional Offices.
 - Provides technical direction for model development.
 - Produced SPAR Model Development Plan – approved by management in user organizations.
- SPAR Model development supported by two NRR User Need Requests
- SRA Counterpart Meetings - SPAR model training, guidance, etc. extensively discussed
- INL Help Desk function to support SPAR model users – extensively used by regional, NRR and RES analysts

8

Related Topics


- SPAR model development is closely linked to SAPHIRE code development - SAPHIRE Version 8 will be an important tool for using the latest SPAR models for event assessment
- Future/Proposed ACRS presentations
 - December 2005 – SPAR-H
 - (proposed) Spring/Summer 2006 – SPAR Data
 - (proposed) Spring/Summer 2006 - SECY 05-0192 dated 10/24/05

11

SPAR MODEL DEVELOPMENT PROGRAM ACTIVITIES

- Level 1, Internal Events - Full Power:
 - 72 Revision 3 SPAR models currently available.
 - 72 Enhanced Rev. 3 SPAR Models in FY07.
- Level 1, Internal Events -- LP/SD:
 - 10 models completed. Onsite QA of 4 models completed.
 - 4 LP/SD SPAR Models in FY07. QA contingent on availability of licensee staff.

9

Idaho National Laboratory


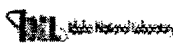
SPAR Model Development & Maintenance: Level 1 Internal Events

ACRS Subcommittee Meeting

Robert Buell
John Schroeder
November 17, 2005

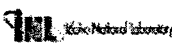
Standardized Structure - continued

- Advantages of standardization
 - Common tool set – SAPHIRE/GEM is the engine for all model development
 - Common skill set – NRC training program assures that all model users have the skills to use the common tool set
 - Uniformity of models helps identify true outlier plants
 - Automation makes industry-wide studies feasible (e.g., the station blackout study)


4

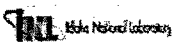
Topics

- Standardized Structure
- Model Demonstration
- Major Modeling Assumptions
- Quality Review of New Models
- Modeling Issues Being Worked
- Model and Parameter Uncertainties
- Model Documentation


2

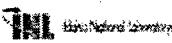
Standardized Structure - continued

- Standardized elements of the SPAR models
 - Methodology
 - Assumptions
 - Initiating events (based on NUREG/CR-5750)
 - No support system initiating event fault trees
 - Event trees (based on peer reviewed class models and consensus elements of PSAs)
 - Fault trees (based on published system studies when possible)


5

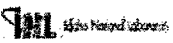
Standardized Structure

- Standardized Plant Analysis Risk (SPAR) Models
 - Evolution of the models
 - Initially a plant-specific implementation of the Daily Events Manual event trees
 - Revision 2QA – Peer review by Sandia National Laboratory, largely subcontracted to SAIC
 - Revision 3I (Interim) – Upgraded during SDP notebook review process
 - Revision 3 – New Seal LOCA model, updated data/templates, updated LOOP/SBO
 - Revision 3P (plus) – cut set level review


3

Standardized Structure - continued

- Standardized elements of the SPAR models - cont
 - Failure data
 - EPIX based template set (1998 – 2002)
 - Common cause failures
 - Methods (NUREG/CR-5485)
 - Data (NPRDS, LERs, EPIX) (1990 – 2001)
 - Loss of offsite power frequency/recovery data (NUREG/CR-5496, 2005 Update to 5496)
 - Human reliability analysis and recovery modeling (SPAR-H, NUREG/CR-6883)


6

Standardized Structure - continued

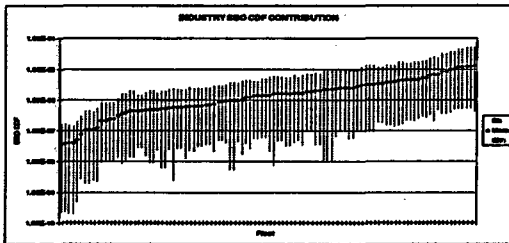
- Standardized structure allows rapid testing/analysis of industry wide issues. This is a significant new tool for regulatory studies.
 - SAPHIRE macro capabilities, in conjunction with standardized, structure allow analyses on all 72 SPAR models in a short period.
 - The recent SBO risk study (NUREG/CR-TBD) is an example of these capabilities.
 - Other potential industry wide examples include
 - What-if data sensitivities
 - MSPI importance measure analyses
 - Etc.

Standardized Structure - continued

- Frontline system fault trees
 - System studies are the basis for RPS, EPS, AFW, HCI, and RCI.
 - Other frontline fault trees include
 - Most active components
 - All obvious operator actions
 - Fault tree guidelines used to simplify models in a standardized way
 - Standard CCF event modelling

Standardized Structure - continued

- Example of recent analysis of SBO risk using SPAR models



Standardized Structure - continued

- Support system fault trees
 - Limited division level AC/DC power model
 - Fluid systems models (SWS, CCW, etc.) same rules as frontline models
 - Air and HVAC systems added as needed
- Human Reliability Analysis - SPAR-H
- Limited recovery modelling
 - Offsite power/diesels
 - Power conversion system
 - Support system initiating events

Standardized Structure - continued

- Small event tree/large fault tree (fault tree linked)
- Standard set of Initiating event candidates
 - LLOCA, MLOCA, SLOCA, XLOCA, ISLOCA, LOOP, LOCHS, LOMFW, TRANS, LOVAC, LOVDC, LOSWS, LOIAS
 - Boiling Water Reactor (BWR) specific
 - IORV
 - Pressurized Water Reactor (PWR) specific
 - LOCCW, SGTR
 - Others added if greater than 1 percent contribution to total CDF in licensee model

Standardized Structure - continued

- BWR general plant transient event tree structure
 - Functional groupings and frontline fault trees
 - Reactor shutdown (RPS)
 - Reactor coolant system integrity (SRV)
 - High pressure injection (MFW, RCI, HCI)
 - Depressurization (DEP)
 - Low pressure injection (CDS, LCI, LCS, VA)
 - Residual heat removal (PCS/CND, SPC, CSS, SDC, CVS)
 - Late injection (LI)

Standardized Structure - continued

- Key BWR event tree assumptions
 - SORV sequences are counted on the IORV event tree.
 - Early suppression pool cooling is required to support RCIC/HPCI operation.
 - Containment venting falls all injection with suction on the suppression pool. (Many LI models include the CVENTED variable.)
 - Containment failure causes loss of all injection. (Many LI models include the CFAILED variable.)

Standardized Structure - continued

- Other transients are based on the TRANS event tree
 - A unique sequence flag set is assigned to each Initiator.
 - The sequence flag set defines the impact vector associated with the Initiator.
 - When the initiator may be recovered, fault tree flag sets may be used to define the impact vector.
 - Choice of fault tree flag set vs. sequence flag set is made to minimize the number of special use fault trees that may be required.

Standardized Structure - continued

- PWR general plant transient event tree structure
 - Functional groupings and frontline fault trees
 - Reactor shutdown (RPS)
 - Steam generator cooling (MFW, AFW)
 - Reactor coolant system integrity (PORV, LOSC)
 - High pressure injection or once through cooling (HPI, FAB)
 - Secondary side cooldown and RCS depressurization (SSC, PZR)
 - Residual heat removal (RHR, HPR)

Standardized Structure - continued

- BWR Loss of coolant accidents (LOCAs)
 - Large LOCAs
 - Reactor shutdown (RPS)
 - Vapor suppression (VSS)
 - Low pressure injection (LPI, LCI, LCS)
 - Residual heat removal (SPC, CSS, CVS)
 - Late Injection

Standardized Structure - continued

- Key PWR event tree assumptions
 - PORV challenge rate is not plant-specific or transient-specific.
 - Two PORVs required for feed and bleed
 - Success of feed and bleed provides time to recover steam generator cooling.

Standardized Structure - continued

- BWR Loss of coolant accidents (LOCAs) continued
 - Medium LOCAs
 - Reactor shutdown (RPS)
 - Vapor suppression (VSS)
 - Depressurization (HCI or DEP)
 - Low pressure injection (LCS, LCI, VA)
 - Residual heat removal (SPC, CSS, CVS)
 - Late Injection (LI)

Standardized Structure - continued

- BWR Loss of coolant accidents (LOCAs) continued
 - Small LOCAs, IORVs
 - Reactor shutdown (RPS)
 - Vapor suppression if included in PSA
 - High pressure injection (MFW, RCI, HCI)
 - Depressurization (DEP)
 - Low pressure injection (CDS, LCS, LCI, VA)
 - Residual heat removal (PCS/CND, SPC, CSS, CVS)
 - Late injection (LI)

Standardized Structure - continued

- PWR Loss of coolant accidents (LOCAs) continued
 - Medium LOCAs
 - Reactor shutdown (RPS)
 - High pressure injection and steam generator cooling (HPI, AFW)
 - Accumulators and steam generator cooling and low pressure injection
 - Cooldown and depressurization (SSC, PZR)
 - Residual heat removal (LPR, HPR)

Standardized Structure - continued

- BWR Loss of coolant accidents (LOCAs) continued
 - Intersystem LOCAs
 - RHR letdown line 2-MOV failure Initiator
 - Pipe Integrity
 - Diagnosis
 - Isolation/Recovery
 - Excessive LOCAs
 - Initiator frequency $1.0E-7$
 - Mitigation failure set to TRUE

Standardized Structure - continued

- PWR Loss of coolant accidents (LOCAs) continued
 - Small LOCAs
 - Reactor shutdown (RPS)
 - Steam generator cooling and high pressure injection (FW, AFW)
 - Once through cooling (FAB)
 - Cooldown and depressurization (SSC, PZR)
 - Residual heat removal (RHR, HPR)

Standardized Structure - continued

- PWR Loss of coolant accidents (LOCAs)
 - Large LOCAs
 - Accumulators (ACC)
 - Low pressure injection (LPI)
 - Residual heat removal (LPR)

Standardized Structure - continued

- PWR Loss of coolant accidents (LOCAs) continued
 - Intersystem LOCAs
 - HPI, LPI, RHR Initiators
 - Pipe Integrity
 - Diagnosis
 - Isolation/Recovery
 - Excessive LOCAs
 - Initiator frequency $1.0E-7$
 - Mitigation failure set to TRUE

Standardized Structure - continued

- SGTR

- Cognitive/Diagnosis failures
- Reactor shutdown (RPS)
- Steam generator cooling (FW)
- High pressure injection and steam generator isolation (HPI, FAB, SGI)
- Cooldown and depressurization (SSC, PZR)
- Terminate or control injection (CSI)
- Alternate heat removal (LTHR)
- Residual heat removal (RHR)
- RWST refill (RFL)

Model Demonstration

- SAPHIRE (Systems Analysis Programs for Hands-on Integrated Reliability Evaluations)
- Project logic models
 - Event trees
 - Fault trees
 - Data

Standardized Structure - continued

- BWR Loss of offsite power/station blackout

- Recovery of offsite power is questioned prior to demand for RHR on LOOP event tree.
- Recovered sequences not developed (Peach Bottom is special case)
- SBO always starts at time zero.
- Emergency power system fault tree is based on simplified lineup.
- Alternate alignments shown on SBO event tree
- During a SBO HPCI/RCIC maintains level only until battery depletion.

Model Demonstration - continued

- Graphical Evaluation Module (GEM) automation
 - Initiating event assessment
 - Code sets observed Initiator to TRUE, others to FALSE
 - Code recalculates LOOP recovery values for observed LOOP class
 - User defines observed failures, degradations
 - Code makes any required CCF adjustments

Standardized Structure - continued

- PWR Loss of offsite power/station blackout

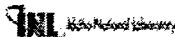
- Recovery of offsite power on LOOP event tree is based on timing of RWST depletion (~6 hr).
 - Two hour recovery allows recovery of condenser (4 hr) and SG cooldown to the condenser followed by RHR.
 - Six hour recovery corresponds to RWST depletion and swapover to recirculation.
- During SBO the time available for recovery is based on the WOG-2000 leak rates.
- The battery depletion limitation is a significant limitation on time available for recovery.

Model Demonstration - continued

- Condition assessment
 - User provides duration of observed condition
 - User provides observed failures/degradations
 - Code makes CCF adjustments
- Common-cause failure adjustments
 - NUREG/CR-5485, Appendix E
 - Component failed (Equation E.11)
 - Component out of service (Equation E.12)
- Standard reports for each assessment type

Major Modeling Assumptions

- General
 - No recovery of AC power after battery depletion
 - CCF not modeled across systems
 - Pre-accident human errors not modeled
 - Run failures occur at time zero.
 - Failures subsequent to AC power recovery in SBO sequences can be neglected
 - Successful diagnosis is implied for all sequences
 - Instrumentation and control not explicitly modeled (implicit in data)
 - Errors of commission not modeled
 - Limited recovery modeling (SS initiators)
 - Service water environmental issues not modeled



31

Quality Reviews of New Models - cont

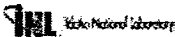
- Model QA procedure
 - Open Items list
 - Completion check list
- Model configuration control
 - Revision Control Software (being studied)
 - Model/Software currency
- Trouble reporting system on SAPHIRE web site
- Proceduralized detailed cut set level review



34

Major Modeling Assumptions - cont

- BWR specific
 - Containment venting causes loss of injection with suction on suppression pool
 - Containment failure causes loss of all injection
 - Suppression pool cooling failure will force early depressurization (loss of HPCI/RCIC)
 - SORV events are included in IORV event tree
- PWR specific
 - Two PORVs are required for feed and bleed
 - Success of F&B allows time to recover SG cooling
 - PORV challenge rate is not plant or Initiator specific



32

Quality Reviews of New Models - cont

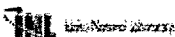
- Detailed cut set level review - cont
 - Purpose of the review
 - Identify the significant differences between PSA and SPAR logic and modify the SPAR models where appropriate
 - The main steps in the review process
 - Obtain a deep cut of the licensee's cut sets and basic event definitions and values
 - Perform a SAPHIRE data-load of the cut sets
 - Identify 150+ of the most important events in the PSA and SPAR models



35

Quality Reviews of New Models

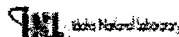
- SPAR Model Review History
 - Peer review performed by Sandia National Laboratory, largely subcontracted to SAIC, led to Revision 2QA.
 - Enhancement/expansion of the models occurred during the SDP notebook review process, led to Revision 3I series of models. QA review using detailed procedure and independent analyst.
 - Most recent modifications incorporate improved RCPSL models, the latest available LOOP/SBO information, and the latest available component failure rates. The resulting model cut sets are now being benchmarked against licensee PSA cut sets.



33

Quality Reviews of New Models - cont

- Detailed cut set level review - cont
 - Establish link between licensee events and SPAR events by coding licensee event name into SPAR basic event "Alternate Event Name" field
 - Build a change set that applies licensee probabilities to SPAR events
 - Load SPAR Importance report and PSA Importance report into comparison spreadsheet
 - Generate Birnbaum comparison plot
 - Identify the outliers and make modifications allowed by SPAR policy and precedent



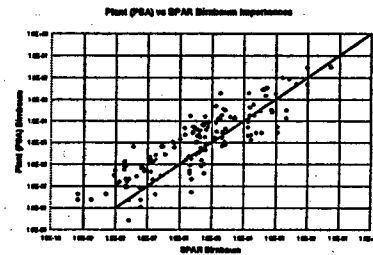
36

Quality Reviews of New Models - cont

- Detailed cut set level review - cont
 - Comparisons are made at various levels of detail
 - Ratio of SPAR model overall CDF to licensee's CDF should be in the range of 0.5 to 2.0
 - Ratio of SPAR model CCDF to licensee's CCDF for each initiating event should be in the range of 0.5 to 3.0
 - Statistical comparison of SPAR basic event Birnbaums with licensee's Birnbaums should be less than 0.2 using comparison metric.

Quality Reviews of New Models - cont

- St. Lucie 2 – After comparison with SPAR data (.55)

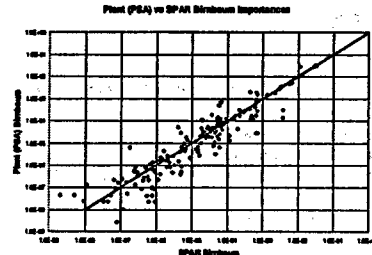


Quality Reviews of New Models - cont

- Detailed cut set level review - cont
 - Comparison metric is average "distance" or "angle" from the line $X=Y$ on the comparison plot
 - "distance" is weighted by log of the value.
 - Events with large Birnbaums contribute more to the metric than events with small Birnbaums

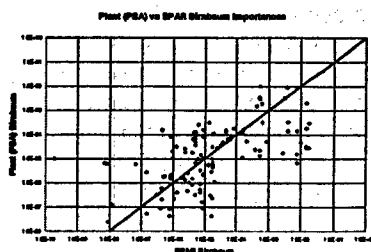
Quality Reviews of New Models - cont

- St. Lucie 2 – After comparison with PSA data (.12)



Quality Reviews of New Models - cont

- St. Lucie 2 – Before comparison with SPAR data (1.9)



Quality Reviews of New Models - cont

- Detailed cut set level review - cont
 - In the preceding figures significant outlying points have a story.
 - The dominant contributors to variance at St Lucie 2 involve CCF of the diesel generators, and DC bus failures.
 - St. Lucie 2 PSA has a much lower AC power recovery failure probability than SPAR model.
 - St. Lucie 2 PSA allows feed and bleed with one PORV.

Quality Reviews of New Models - cont

Plant	SPAR CDF - Nominal Data	SPAR CDF - PSA Data	PSA CDF
Columbia	3.14E-6	8.44E-6	6.36E-6
Indian Point 2	9.01E-6	9.22E-6	1.10E-5
Indian Point 3	8.70E-6	1.95E-5	1.14E-5
Kewaunee	1.63E-5	6.38E-5	3.83E-5
Oconee	7.42E-6	1.37E-5	2.28E-5
Paisades	2.73E-5	8.99E-5	7.00E-5
Pilgrim	1.29E-5	1.07E-5	6.39E-6
St. Lucie 1	4.91E-6	2.25E-5	2.27E-5
St. Lucie 2	3.99E-6	2.86E-5	2.15E-5
Susquehanna	4.08E-6	1.75E-6	3.06E-6
Turkey Point	2.70E-6	7.12E-6	4.25E-6

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Loss of offsite power modeling
 - Updated LOOP recovery curves
 - Updated RCP seal LOCA models
 - 24 hour emergency diesel generator mission
 - Two part emergency diesel generator hazard curve
 - Convolution of time based failures

Quality Reviews of New Models - cont

- SPAR CDF (PSA Data)/PSA CDF
 - Mean = 1.1
 - Variance = 0.2
- SPAR CDF (Nominal Data)/PSA CDF
 - Mean = 0.86
 - Variance = 1.9
- Mean of 0.86 with SPAR data suggests SPAR data have lower failure values than analogous PSA data.
 - Transient initiating event frequency
 - Turbine driven pumps
 - Emergency diesel generators
- Mean of 1.1 with PSA data suggests SPAR logic is conservative when compared to PSA logic.
 - No recovery after battery depletion
 - Two PORV success criteria

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - RCP seal failure modeling
 - WOG 2000
 - Four seal failure modes with probabilities and associated leak rates
 - Core uncover times per Westinghouse Emergency Procedure Guidelines
 - CE draft report
 - Three factors considered (timing, CBO, subcooling)
 - Core uncover times per draft report
 - B&W plants
 - Westinghouse or Combustion Engineering seal failure models used

Modeling Issues Being Worked

- Important modeling issues and status
 - Loss of offsite power modeling - Models updated
 - RCP seal failure modeling - Models updated
 - CCF Modeling - Models updated
 - Data values - Models updated
 - Sump plugging values - Pending NRC resolution
 - Support system initiating event fault trees (Working)
 - Power recovery after battery depletion (Working)
 - Continued Injection after containment failure (TBD)
 - PORV success criteria during feed and bleed (TBD)
 - Time to core uncover (TBD)

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - CCF Modeling
 - Alpha factor methodology
 - Equivalent to MGL methodology
 - Alpha factors recently updated
 - Conditional CCF calculations
 - Component failed (TRUE)
 - Component out of service (One)

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Data values
 - SPAR past - system study data (circa -1990)
 - SPAR current - EPIX based data
 - Industry - Bayesian update of old generic sources with current plant specific data.
 - Data and methodology for inclusion of SWS environmental effects (water quality) is under development.

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Power recovery after battery depletion
 - SPAR models give no credit for power recovery beyond battery depletion
 - Significant impact on SBO CDF
 - Significant impact on EDG importances
 - Considerations include
 - Diesel-driven injection sources
 - Availability and quality of procedural guidance
 - Capacity of water sources for continued injection, room heatup and other environmental concerns, duration of emergency lighting, switchyard battery life, etc

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Sump plugging values
 - NUREG/CR-6762, GSI-191 Technical Assessment: Parametric Evaluations for Pressurized Water Reactor Recirculation Pump Performance.
 - $LLOCA_{PWR} * 0.6 \sim 3E-6$ Increase in CDF
 - $MLOCA * 0.1 \sim 4E-6$ Increase in CDF
 - $SLOCA_{PWR} * 0.01 \sim 4E-6$ Increase in CDF

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Continued injection after containment failure
 - BWR issue
 - Industry credit varies widely (1.0 to 0.0)
 - Significant impact on importances of decay heat removal equipment
 - Issues
 - Environmental (steam)
 - Depressurization rates
 - Ability to inject with low pressure sources
 - Break location
 - Failure pressure, etc

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Support system initiating event fault trees
 - Point value
 - Underestimates event importances
 - Does not account for specific system configurations
 - Fault trees
 - Better estimate of event importances
 - Accounts for specific system configurations
 - Two general approaches
 - Multiplier method
 - Explicit events

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - PORV success criteria during feed and bleed
 - SPAR success is two PORVs in absence of detailed thermal hydraulic calculations
 - No consensus in industry PSAs
 - Industry approximately evenly split between one and two PORVs
 - No apparent correlation of PORV success to key factors such as relief capacity, injection pressure/capacity, etc.

Modeling Issues Being Worked - cont

- Important modeling issues and status - cont
 - Time to core uncover
 - SPAR timing to core damage generally based on thermal hydraulic data from NUREG-1150
 - LOOP/SBO RCPSL core uncover based on information in Westinghouse Emergency Procedure Guidelines and Combustion Engineering documents
 - Miscellaneous timing data from other NUREGs
 - SPAR project does not perform detailed plant-specific thermal hydraulic analyses

Modeling Issues Being Worked - cont

- Future Enhancements
 - Splitting Transient event tree into LOCHS, LOMFW & TRANS
 - Addition of new SGTR logic
 - Dual/single unit LOOP logic
 - Consequential seal LOCA logic in Westinghouse plant models
 - Addition of lower importance initiators (>1%)
 - Additional detail in PWR main feedwater fault trees
 - Incorporate standardized ISLOCA methodology
 - Benchmarking against PSA cut sets
 - HEPs calculated using SPAR-H interface in SAPHIRE
 - To be included pending resolution of issues
 - Develop/implement fault tree based initiating events for support system initiators
 - Integrate all SPAR based logic into single master model (Level 1, LERF, Fire, Flood, External Events, LP-SD, etc)

Modeling Issues Being Worked - cont

- Loss of service water initiator frequency
 - Support system initiating event fault trees
 - Service water system study (environmental issues)
- Addition of low importance initiators
- Allocation of all bus failure initiating event failures to a single bus
- Steam generator tube rupture logic
- General modeling of common cause (cross-products)
- Simplified modeling of emergency diesel alignments

Model and Parameter Uncertainties

- Data Uncertainty (Standard template list)
 - Initiating event frequencies
 - Component failure rates
 - Plant specific vs. generic data
 - Offsite power recovery failure parameters
 - Diesel generator recovery failure parameters
 - Alpha factors

Modeling Issues Being Worked - cont

- Recent Changes to the Models
 - New failure data including CCF alpha factors
 - Global use of template events including alpha factors
 - New reactor coolant pump seal LOCA logic
 - New LOOP initiator and offsite power recovery modeling
 - Conversion of CDF from 'per hour' to 'per year'

Model and Parameter Uncertainties - continued

- Model structure uncertainty
 - Plant-by-plant list of major issues
 - Estimate of issue impact
 - Resulting issues include
 - Support system initiating event fault trees (e.g., SWS environmental issues)
 - Power recovery after battery depletion
 - Continued injection after containment failure
 - Sump plugging values
 - Success criteria (PORVs required during FAB, other)
 - Time to core uncover

Model and Parameter Uncertainties - continued

- Uses of expert/licensee's judgment
 - Continued injection given containment failure
 - Recovery of power after battery depletion
 - Operation of turbine-driven pumps without indication/control
 - Seal LOCA model
 - Large/Medium LOCA frequencies

Model documentation

- Sections in main report
 - Introduction
 - Initiating events
 - Translation from early reports
 - BWR summary table
 - PWR summary table

Model and Parameter Uncertainties - continued

Key Sources of Uncertainty	SPAR Application
General data source/uncertainty	Eide & Rasmussen data and uncertainty
Plant specific vs. generic data	Generic industry wide data
HRA Methodology	SPAR-H Methodology
Stump plugging values	Generic value used until issue is resolved
Support system initiating event fault trees (e.g., SWS environmental issue)	Currently use point estimates while researching this issue
Power recovery after battery depletion	Currently no credit given, evaluating giving credit in limited applications
Run failures occur at time zero	Convection not credited, evaluating
Success criteria	2 PORV min for FLS, licensee's in general
Seal LOCA model	WOG 2000 guidance
Continued injection after atm failure	Moving from no credit to that of licensee
Diesel generator run time	24 hour mission
Large/Medium LOCA frequencies	NUREG/CR-6780 values
Operation of TDPs without DC power	High screening value used

Model documentation - continued

- Event tree models
 - Descriptions
 - Graphics
 - Success criteria
 - Linkage rules/flag sets

Model documentation

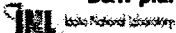
- Sections in main report
 - Introduction
 - Initiating Events
 - Event Tree Models
 - Fault Tree Models
 - Basic Event Data
 - Common Cause Failure Model
 - Reactor Coolant Pump Seal Model
 - Loss of Offsite Power Model
 - Human Reliability Model
 - Baseline Results

Model documentation - continued

- Fault tree models
 - Fault tree modeling guidelines
 - Fault tree notes and comments
 - System dependency matrix
- Basic event data
 - Template events
 - Compound events
 - Template event data table

Model documentation - continued

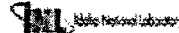
- Common-cause failure (CCF) model
 - Introduction to the Alpha Factor Method
 - Use of the CCF library module
 - Mention of special use capability
 - Set CCF input to TRUE
 - Set CCF input to 1.0
- Reactor coolant pump seal failure model
 - Westinghouse plants
 - Combustion Engineering plants
 - B&W plants



67

Topics for In-depth Discussions

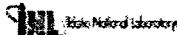
- Initiating event fault tree issues and development
- Convolving time based (run) failures



70

Model documentation - continued

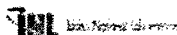
- Loss of offsite power model
 - LOOP recovery failure calculations
 - Diesel recovery failure calculations
- Human reliability model
 - Alignment, control, and operate events
 - System hardware recovery events
 - Summary table
 - Recovery rule listing
- Baseline results



68

Model documentation - continued

- Appendices
 - Fault tree graphics
 - Basic event data report
 - Compound event data report
 - Common cause failure event data report
 - HRA worksheets
 - Revision log
 - Simplified piping diagrams



69

STANDARDIZED PLANT ANALYSIS RISK (SPAR) MODEL DEVELOPMENT PROGRAM

LESSONS LEARNED FROM MSPI PRA QUALITY REVIEWS

Donald A. Dube
Operating Experience Risk Analysis Branch
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
November 17, 2005



1

What is the MSPI ?

- *A measure of the deviation of plant system unavailability and component unreliabilities from baseline values, weighted by plant-specific risk importance measures*
- $MSPI = UAI + URI$
- For unreliability:

$$B_i (UR_i - UR_{IBL})$$

summed over all monitored components i in the system.
The coefficients B_i are the component basic event
Birnbaum importance values.

2

Recommendations of PRA Quality Task Group

- Licensees should assure that their PRA is of sufficient technical adequacy for MSPI by:
 - (a) Resolving the A and B F&O's from the peer review
 - (b) Performing a self-assessment using the NEI-00-02 process as endorsed by Appendix B of RG 1.200 for the ASME SLRs Identified by the task group as being important to MSPI
- As alternative to (b) the Industry has proposed and the NRC staff has agreed to rely on a cross-comparison of PRAs. The staff performed an additional review of industry values by comparing their PRA Birnbaum values to SPAR values.

3

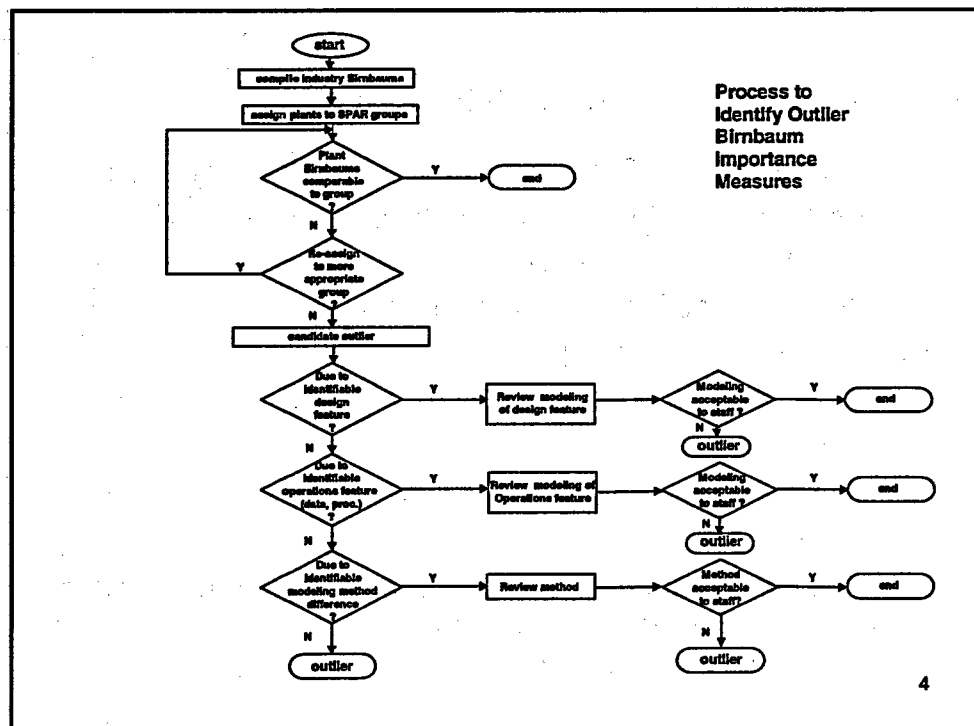
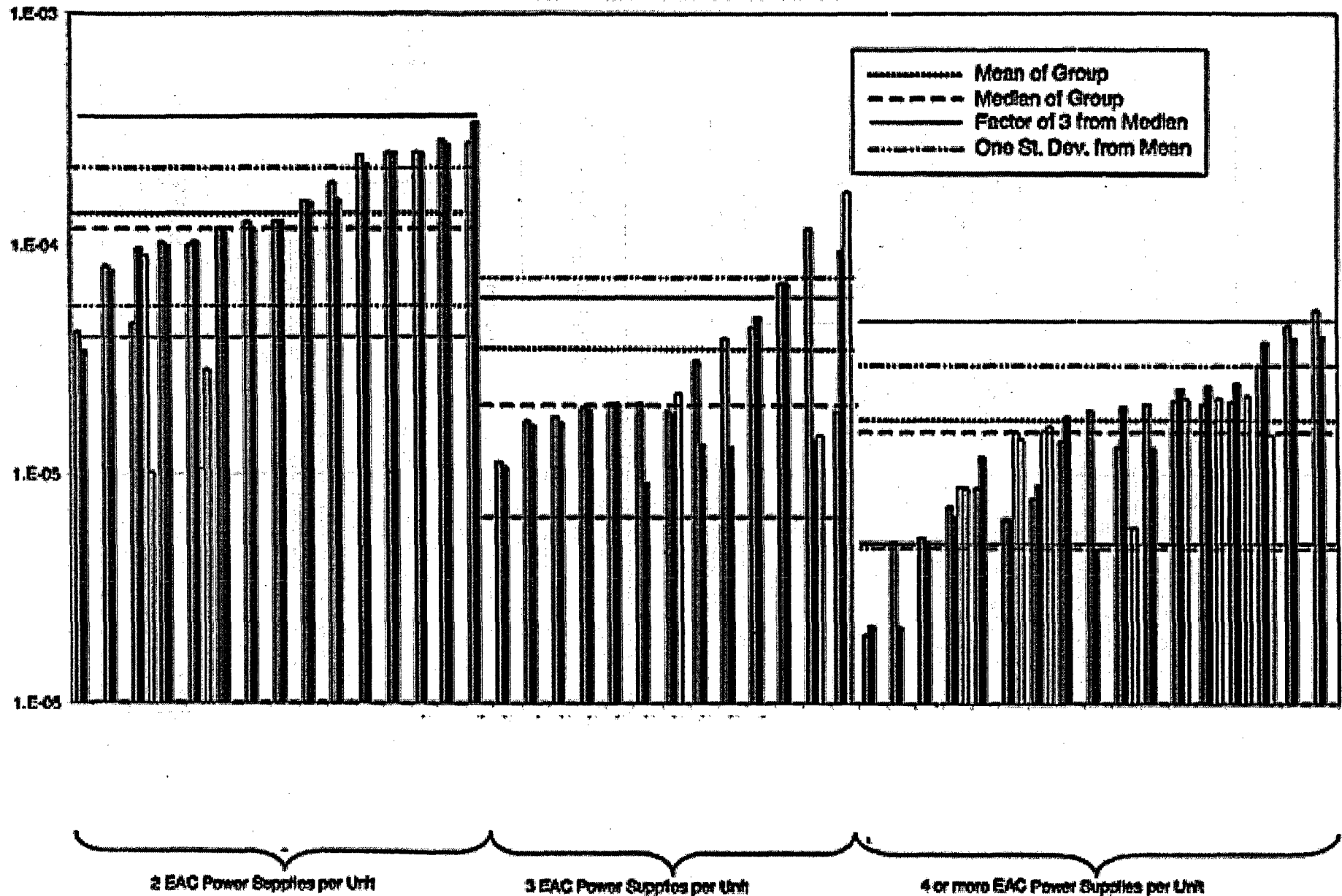
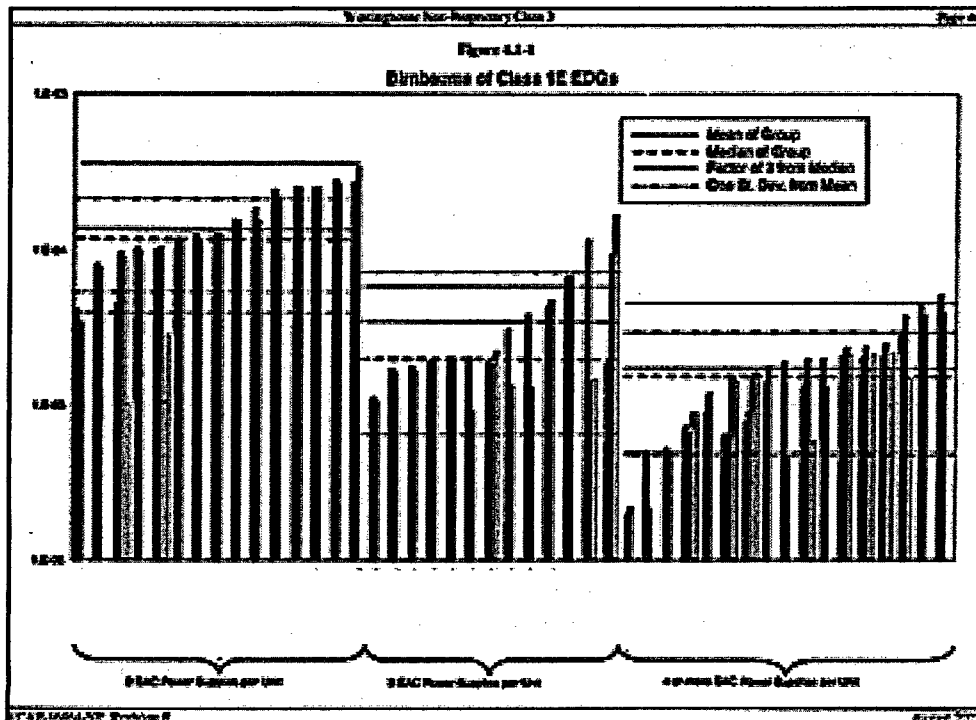


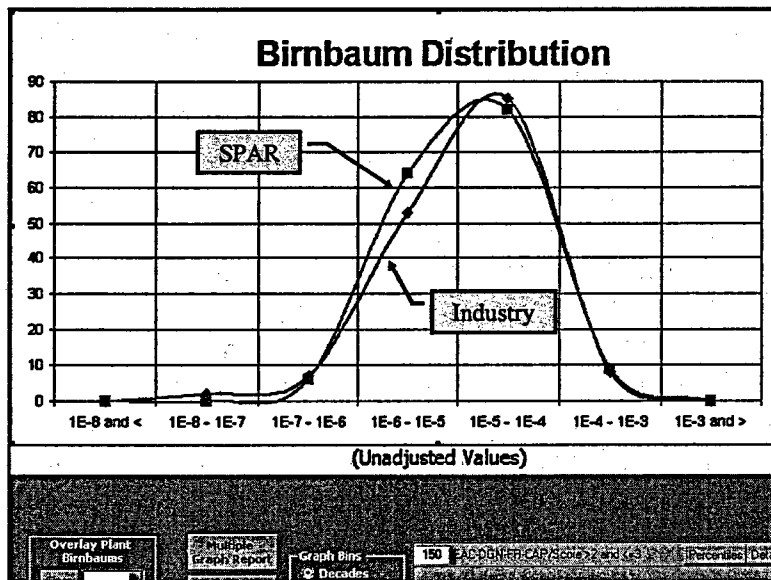
Figure 4.1-1

Blmbaums of Class 1E EDGs

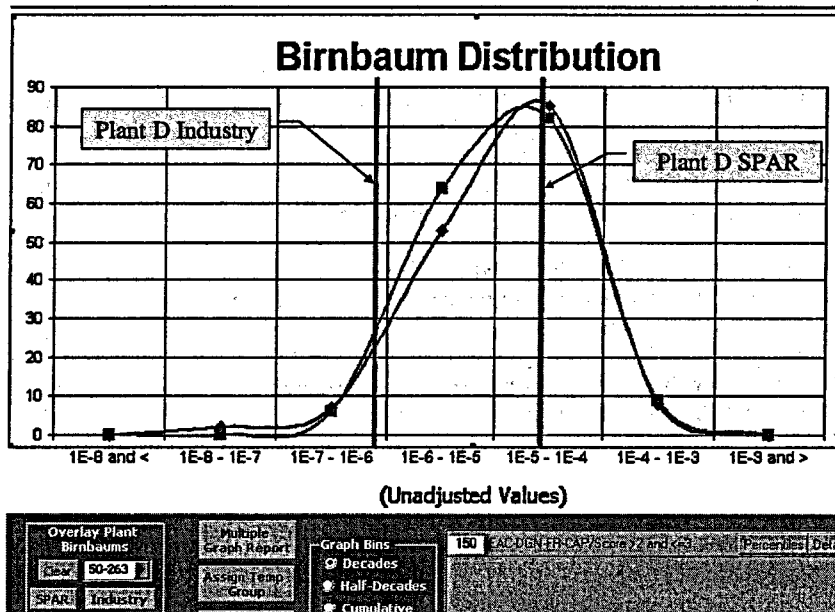




Electrical Generators - Grouped Capability/Score >2 & ≤ 3

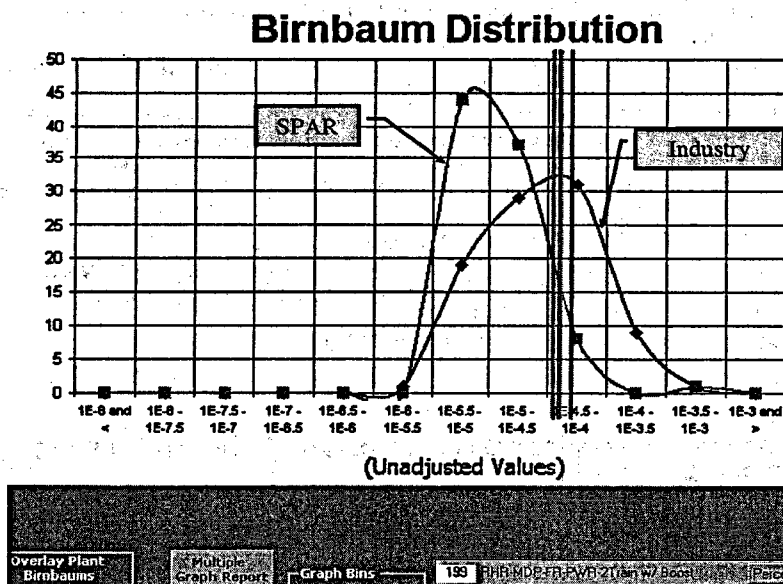


Electrical Generators - Grouped Capability/Score >2 & ≤3



7

RHR MDPs - PWR 2 PP Systems w/ HPR Booster Function



8

Summary of MSPI PRA Issues

Open A&B Facts and Observations possibly affecting MSPI	16
Model truncation & convergence issues	14
Low loss of offsite power frequency issues	9
Low loss of service water frequency issues	5
Missing support system adjustment contribution to F-V	5
BWR 5/6 credit for RPV injection after containment failure	5
Station Blackout mitigation strategies issues	4
Offsite power recovery issues (after battery depletion, etc)	4
Unexplained model asymmetry issues	3
Common cause factor analysis issues	2
Control of turbine-driven pump without DC power	2
Low loss of DC bus Initiator frequency	1
Missing test & maintenance basic event for EDGs	1

9

Summary of MSPI Generic SPAR Issues

- Loss of emergency AC power bus Initiator frequency about an order of magnitude higher than industry average.
- Pressurizer PORV success criterion for feed and bleed is assumed to be two irrespective of plant design and analysis.
- Modeling asymmetries (e.g., loss of DC bus on only one division).
- Single value loss of service water frequency irrespective of plant site and design.
- Higher failure probability for local, manual control of turbine-driven AFW pump.
- Old RCP seal LOCA model for B&W plants.
- Small-LOCA frequency is lower than industry norm by nearly an order of magnitude because it does not include lower end of spectrum (e.g., small-small LOCAs).
- Instances where SPAR did not model T&M.

These issues are being addressed as part of the enhanced Rev 3 SPAR models.

10