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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

OCTOBER 5, 2000

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

1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

3 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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5 476th MEETING

6

7 Two White Flint North

8 Room T2-B3

9 11545 Rockville Pike

10 Rockville, Maryland

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12 Thursday, October 5, 2000

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14 The committee met, pursuant to notice, at 8:30 a.m.

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1 MEMBERS PRESENT:

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3 DANA A. POWERS, Chairman

4 GEORGE APOSTOLAKIS, Vice Chairman

5 MARIO V. BONACA

6 THOMAS S. KRESS

7 GRAHAM M. LEITCH

8 ROBERT L. SEALE

9 WILLIAM J. SHACK

10 JOHN D. SIEBER

11 ROBERT E. UHRIG

12 GRAHAM B. WALLIS

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

2 [8:30 a.m.]

3 DR. POWERS: The meeting will now come to order.

4 This is the first day of the 476th meeting of the

5 Advisory Committee on Reactor Safeguards.

6 During today's meeting, the committee will consider

7 the following:

8 Discussion of Union of Concerned Scientists report,

9 "Nuclear Plant Risk Studies: Failing The Grade";

10 NEI 00-02, "Industry PRA Peer Review Process

11 Guidelines";

12 Staff views on the ASME standard for PRA for nuclear

13 power plant applications;

14 And pressurized thermal shock technical bases

15 reevaluation project.

16 We will also discuss proposed ACRS reports, and we

17 will discuss the topics to be raised in our meeting with the

18 Commissioners tomorrow.

19 Our meeting today is being conducted in accordance

20 with the provisions of the Federal Advisory Committee Act.

21 Dr. John D. Larkins is the designated Federal official for the

22 initial portion of the meeting.

23 We have received no written comments from members

24 of the public regarding today's sessions.

25 A transcript of portions of the meeting is being

1 kept, and it is requested that the speakers use one of the
2 microphones, identify themselves, and speak with sufficient
3 clarity and volume so they can be readily heard.
4 I want to bring to the members' attention that Jim
5 Lyons is now on-board as our Associate Director for Technical
6 Support.
7 Welcome aboard, Jim.
8 MR. LYONS: Thank you. I'm glad to be here, happy
9 to serve and see what we can do to make everything work as
10 well as possible.
11 DR. POWERS: And we'll all do our best to try to
12 really confuse him in his first few days.
13 DR. SEALE: We'll see what we can do.
14 DR. POWERS: Now I have some good news and some bad
15 news.
16 Let me start with the bad news.
17 The bad news is Lilly Gaskins is leaving us for
18 greener pastures. She's going off -- Defense Intelligence
19 agency?
20 MS. GASKINS: Yes.
21 DR. POWERS: Lilly, I want to say we've very much
22 appreciated having you here, and we're going to be
23 disappointed, but our loss is their gain.
24 [Laughter.]
25 [Applause.]

1 DR. POWERS: Now for the good news.

2 Our own Carol Harris, Miss Carol Harris, has now
3 become Ms. Carol Harris.

4 [Applause.]

5 DR. POWERS: Very best wishes from the committee,
6 Carol, and we'll harass you like crazy.

7 MS. HARRIS: I count on it.

8 [Laughter.]

9 DR. POWERS: Members do have a hand-out called
10 "Items of Interest."

11 I'll call to your attention that the water reactor
12 safety information meeting is coming up, and I also call to
13 your attention that the staff has issued their report on the
14 Indian Point 2 incident.

15 With that, I'll ask, are there any opening comments
16 that members would like to begin?

17 [No response.]

18 DR. POWERS: Seeing none, I think we can move to the
19 first of our sessions, which is a discussion of the recent
20 report by the Union of Concerned Scientists concerning nuclear
21 plant risk studies.

22 Professor Apostolakis, do you want to lead us in
23 this session?

24 DR. APOSTOLAKIS: Okay. Thank you, Mr. Chairman.

25 This report was issued last August, and it is very

1 critical of the NRC's risk-informed initiative, and this
2 committee has been very supportive of that initiative. So,
3 naturally, we were interested in understanding better what the
4 arguments of the report were.
5 Mr. Lochbaum happened to be in the building last
6 time we were here and very graciously agreed to come and chat
7 with us in an informal way, but we felt that the more formal
8 forum was needed, so we scheduled this hour-and-a-half today,
9 and Mr. Lochbaum is here.
10 So, how would you like to proceed? Would you like
11 to make some opening statements? You have transparencies, I
12 see.
13 MR. LOCHBAUM: I have approximately 10 or 15 minutes
14 of stuff, and then I'd be glad to entertain any questions or
15 comments.
16 DR. APOSTOLAKIS: Why don't we go that way, then?
17 MR. LOCHBAUM: Okay.
18 Roughly two months ago, we released a report called
19 "Nuclear Plant Risk Studies: Failing The Grade." Almost
20 immediately, we heard criticism that the report was flawed
21 because we relied primarily on data from the individual plant
22 examinations that had been done and not information from the
23 more recent plant safety assessments that each plant owner
24 does.
25 The reason we used the IPE results is because those

1 are really the only results that are publicly available. So,
2 we didn't have access to anything other than that information.
3 We also found it curious that the NRC was among the
4 ones criticizing us for using the IPE results. Yet, in the
5 site-specific work-sheets for use in the significant
6 determination process, it's the IPE data the NRC uses, not the
7 PSA data.
8 So, you know, on one hand, we're criticized for
9 using the data by the NRC that the NRC itself uses.
10 So, I guess I didn't realize it was proprietary in
11 that nature.
12 We also heard that some folks argue that our
13 evaluation, specifically the case studies that we did in our
14 evaluation, were flawed because our conclusions were that the
15 case studies prove that the risk assessments were bad because
16 the results are so different for plants of similar design.
17 In fact, I met, within the last week or so, with one
18 critic of our report, who said that the plants are different,
19 even plants at the same site are different, and those
20 differences drive the risk assessments results to be
21 different, so it's more surprising when the results are the
22 same than when they're different.
23 So, we heard that criticism, and we wanted to look
24 into it a little bit.
25 So, we went to the NRC's IPE database that's on the

1 internet, and these following three sheets are from that
2 database.
3 I just printed out the overall core damage frequency
4 from the IPE database and had sorted it from high to low, and
5 I notice, with the exception of a few plants, Hatch 1 and 2,
6 St. Lucie 1 and 2, Indian Point 2 and 3, Salem 1 and 2, and
7 Beaver Valley 1 and 2, all multiple-unit sites that have
8 similar reactor designs have the exact same core damage
9 frequency reported for all units.
10 So, if, indeed, the plants are different enough to
11 drive the risk results -- assessment results different, then
12 that's not done on a consistent basis. Sometimes it is,
13 sometimes it isn't, and apparently, the NRC is happy whether
14 the results are the same or whether the results are different,
15 and like I say, that IPE database has all the plant results,
16 even for plants that are now closed.
17 DR. APOSTOLAKIS: So, are these so-called sister
18 plants, or it's just a listing of the plants?
19 MR. LOCHBAUM: This is a listing of the IPE results
20 that all the plants submitted. Some of them are sister units
21 and some of them are not.
22 For example, Millstone -- obviously, they're at the
23 same site, but they're different reactors. I wouldn't expect
24 those numbers to be the same, and they're not.
25 DR. APOSTOLAKIS: But your argument in the report

1 is that sister plants report different results.

2 DR. UHRIG: Well, St. Lucie -- they have different

3 cores. One has 14-by-14 and one has 16-by-16, and there's a

4 lot of other design features that are different.

5 MR. LOCHBAUM: The same thing is true with Brown's

6 Ferry. Even plants at the same site operate differently,

7 whether it's the core design or the cooling water system

8 design or whatever, because I don't think there's any -- it's

9 like snowflakes. No two nuclear power plants are identical,

10 even at the same site, yet the results are the same and are

11 not the same.

12 I understand the criticism. I don't know -- based

13 on the data, I can't confirm or refute it, because we have

14 some in both categories.

15 DR. APOSTOLAKIS: Would you like us to raise

16 questions as you go along or wait until you're done?

17 MR. LOCHBAUM: Either way, whichever is easiest for

18 you.

19 If it makes more sense to ask me a question about

20 it as we're going --

21 DR. APOSTOLAKIS: Okay. Let's pick up this issue.

22 The issue -- I guess you are making the point that

23 the PRA is such a weak technology that, when applied -- or

24 immature, perhaps -- that when applied by two different groups

25 to two plants that are very similar, it produces different

1 results.

2 MR. LOCHBAUM: That's correct.

3 DR. APOSTOLAKIS: This is an issue, as you probably
4 know, that the staff identified in its report on lessons
5 learned and insights from the IPE reviews.

6 So, it is really nothing new there except that you
7 are taking a little more extreme position, but it's really the
8 methodology that is the culprit here and not so much the
9 design differences.

10 The staff's conclusion was that, from the evidence,
11 they could not conclude whether it was really the methodology
12 or the design features, although they do say somewhere there,
13 as I recall, that the differences were primarily driven by
14 design and operation differences.

15 So, I mean there are differences, and it's not just
16 -- I mean it also depends very much on what you call sister
17 plants, and my colleague, Dr. Bonaca, has more experience in
18 that, and maybe you can say a few words.

19 MR. BONACA: Oftentimes, we talk about sister plants
20 on different sites, and when you look at them, really,
21 oftentimes they are different on the secondary site, because
22 the AE was different, because they were implemented in
23 different ways.

24 So, the sister plant connotation is one that relates
25 more to the NSS island than to the balance of plant, and yet,

1 the balance of plant is critical in determining some of the
2 results in the PRA. For example, the layout of the auxiliary
3 feedwater system is a fundamental element looking at the
4 results.
5 Now, on the same site, you have some plants that
6 probably are sister plants, and maybe the case was made by the
7 applicant, like Calvert Cliffs, that they're identical,
8 therefore we submit only one IPE. I will expect that probably
9 was the approach taken.
10 On some sites, there may significant differences and
11 you have different values.
12 But one point I wanted to make is that that's why
13 we don't like to see a bottom line number for a PRA. We're
14 looking at uncertainty.
15 If you take two teams doing a PRA for the same
16 plant, you will get different results, no question about it.
17 If you get two different vendors doing a LOCA analysis for the
18 same plant, the same fuel, we get different results. Nobody
19 expects to get the same value.
20 What you expect to see, in fact, is a reflect of the
21 uncertainty in the whole evaluation reflected in the two
22 assessments, and I don't think it's surprising.
23 I think it actually would be a healthy insight to
24 have two different estimates of the same matrix for the plant,
25 so you could understand what the subtleties are and what the

1 effects are.

2 MR. LOCHBAUM: I don't disagree with that. In fact,
3 you know, the plants are different, and therefore, the results
4 should be -- if the result -- different results are due to
5 plant differences, that's one thing. If the different results
6 are due to different methodologies and both methodologies are
7 the same, six of one, half-a-dozen of the other, then that's
8 fine, too.

9 What we're concerned about is the lack of controls
10 over the methodology and the assumptions in inputs that would
11 allow a plant owner to -- if they're contemplating a
12 modification to the plant or a procedure change -- for
13 example, putting kerosene in the fire water headers -- to go
14 back and adjust the inputs to compensate for the actual
15 increase in risk from the proposed change, make some
16 methodology hand-waving to make it look -- the net effect to
17 be the same or even an improvement in safety.

18 We're concerned that the controls over the
19 methodology and the assumptions wouldn't prevent those kind
20 of abuses, whether intentional or mistaken.

21 DR. APOSTOLAKIS: I believe you are absolutely right
22 on that, and this committee has been concerned about it, and
23 the staff has made it clear that they are concerned about it.
24 So, I think there is no question that, in some IPEs, people,
25 whenever they found an opportunity, they were more optimistic

1 than the general state of knowledge would justify, but it
2 seems to me that the real question -- and I think that's an
3 issue that one can raise in several places in your report --
4 is not so much whether there are studies that are not really
5 very good out there.
6 The question should be, at least in my view, has the
7 NRC used any of these studies in its decision-making process
8 and was led to incorrect conclusions because the NRC was
9 unable to identify the sources of the differences, perhaps?
10 I mean it all comes down to decision-making.
11 I think we should make it very clear that, you know,
12 the industry -- it's a private industry that can do studies
13 for themselves, and if they want to use optimistic numbers,
14 that's up to them, but when it comes to the agency, does the
15 agency accept these analyses, and do you have any examples
16 where, indeed, the agency used what, in your view, were
17 inadequate PRAs to make a decision, because that's really the
18 heart of the matter, the decision-making process.
19 MR. LOCHBAUM: I guess we didn't, because the agency
20 is clearly moving towards risk-informed regulation, and the
21 risk assessment results are going to be an input or a factor
22 in that regulatory decision-making.
23 We wanted to try to prevent some bumps in that road.
24 We're not saying that the road is wrong. There are some
25 problems along the way that we wanted to try to address in our

1 report and get fixed before we proceeded too far down that
2 road.
3 So, the answer to the question is, no, we don't have
4 any examples, but also, we didn't look, because we were trying
5 to prevent mistakes in the future, rather than flag errors of
6 the past.
7 DR. APOSTOLAKIS: This answer, I must say, is really
8 surprising to me, because by reading the report, I didn't get
9 the impression that you were trying to prevent mistakes from
10 happening.
11 I mean the report gives the impression that things
12 are very bad.
13 So, I must say your statement is very welcome, to
14 me, at least, because the committee, of course, does not have
15 a position at this point.
16 So, if that was your intent, I think you're
17 succeeding, but it doesn't come through by reading the report
18 that you are really trying to prevent mistakes from happening.
19 I mean "Failing The Grade" is a pretty strong statement to put
20 in the title.
21 MR. LOCHBAUM: I think we have some data to show why
22 we think the risk assessments are bad. We didn't look for any
23 examples where those results have been used yet, but the
24 agency is moving in that direction, and that's what troubled
25 us.

1 DR. APOSTOLAKIS: But you do agree that this is
2 really what the issue is, I mean the decision-making process.
3 I mean, you know, a private company can do whatever they like,
4 if they want to kid themselves that the risk is 10 to the
5 minus 20, but when they try to use it here, then it's a
6 different story.
7 MR. LOCHBAUM: Well, I think the related question
8 -- and I agree that that is the question, but the related
9 question that Commissioner McGaffigan poses is, would this
10 information or this approach lead the NRC to a different
11 answer than it would using the current prescriptive approach,
12 you know, because errors can be made on either side.
13 DR. APOSTOLAKIS: And that brings up another major
14 question that I have. I don't know whether I should raise it
15 now or later.
16 MR. LOCHBAUM: One of the other criticisms we had
17 was our concern about the risk assessments not accounting for
18 design basis problems, and the bulk of that criticism was
19 that, yes, design basis problems have been identified, but
20 they haven't been risk-significant; they've been much ado
21 about nothing, if I can characterize the criticism, if I
22 understand it correctly, and to investigate that criticism,
23 we went to a recent -- a May 2000 draft report that the Office
24 of Research prepared on the design basis problems, and this
25 is Figure 22 from that report that looks from 1990 to 1997.

1 The number -- the percentage of LERs with design
2 basis issues that have been classified as accident sequence
3 precursor events -- and while the trend is, indeed, downward,
4 the important part that we think is that none of the years is
5 non-zero.
6 So, not all of design basis problems that have been
7 reported have been able to be dismissed as
8 non-safety-significant.
9 DR. POWERS: I guess I'm a little bit confused.
10 Would you expect it to go to zero? I mean I can hope it goes
11 to zero, but I wouldn't expect it to.
12 MR. LOCHBAUM: That's true. I wouldn't expect it
13 to, but since the risk assessments basically assume that it's
14 zero, then there's a disconnect between reality and the risk
15 assessment assumptions, and that disconnect is what --
16 DR. POWERS: I don't think -- I mean it doesn't seem
17 to me that the risk assessments assume this is zero. They
18 assume these things actually occur. Most of the accident
19 events result in nothing happening.
20 In a typical modern PRA, there are, what -- I think,
21 for 1150, the average one had three million accident
22 sequences, of which nearly all of them ended just like these
23 precursors ended, no consequences.
24 I mean I can go through the 1150 and actually give
25 a prediction on how often those things that are recorded there

1 should occur.

2 MR. LOCHBAUM: I guess the point we look at is, for
3 example, the stand-by liquid control system we talked about
4 in our report -- the Big Rock Point plant operated for 13 --
5 the last 13 years of its 39-year life with that system not
6 working quite right.

7 The risk assessments don't reflect --

8 DR. POWERS: Nor does the design basis analysis
9 reflect -- nor does anything -- if you don't know that
10 something is not right, there is no amount of analysis you
11 could ever do in your entire life, by the most intelligent
12 people, impossible, that will discover that if it's not
13 discovered.

14 I mean it's a non-criticism.

15 MR. LOCHBAUM: But once something becomes a reported
16 event, it doesn't seem that design basis events are factored
17 back into the process, like human errors. There's a human
18 error database. There's an equipment failure database. There
19 doesn't seem to be a design deficiency database or -- a widget
20 just doesn't work because it's designed improperly.

21 If the widget doesn't work because somebody
22 mis-operates it, that seems to be captured. You can argue
23 whether it's right or wrong, but at least it's captured. If
24 the widget doesn't work because it fails on start or fails on
25 demand, then that seems to be in there. But if the widget is

1 designed improperly, that doesn't seem to be in the risk
2 assessments, and you know, any one of those failures in any
3 one of those columns can cause something from working
4 properly.
5 DR. SEALE: I'm curious as to what's driving that
6 curve down, then.
7 MR. LOCHBAUM: Well, I would hope one of the factors
8 would be, as you find things and fix them, you have a work-off
9 curve.
10 MR. BONACA: I would like to make a comment about
11 this point.
12 This is the trend, and that's the trend, but we have
13 to recognize that we didn't look -- I mean one thing we found
14 is, the more we look, the more we find, and we looked the most
15 between 1995 and 1997.
16 To me, it's comforting that that number of
17 precursors is so low in the very period in which we looked so
18 much, and there was a limit to how much we found.
19 The other point I would like to make is that, again,
20 for those precursors there, you know, there wasn't a
21 terminicity evaluation or system failures that did not
22 represent the range of operation in which the system should
23 operate.
24 There were some conditions that, in the
25 deterministic space, says the system is not functional or is

1 not operable.

2 So, anyway, that's a different issue, but the point

3 I would like to stress here is it's -- this trend -- it's

4 encouraging in my mind, because we looked so much in '95-'97

5 timeframe, and we found, you know, we didn't upset that curve.

6 MR. LOCHBAUM: I guess you could -- statistics can

7 be looked at any number of ways. You could look at -- with

8 all the things that reported in the '95 to '97 timeframe, the

9 percentage would go down, because this is not absolute number,

10 this is percentage, and there were so many less significant

11 items found, as all those problems were flushed out, that the

12 percentage would have gone down even if the absolute numbers

13 stayed the same.

14 MR. BONACA: There was also a finding that, again,

15 the more you look, the more you find, and there was a lot of

16 looking, and so, many of these issues were to do with original

17 design.

18 MR. LOCHBAUM: Seventy percent of them, according

19 to this report, by the way.

20 MR. BONACA: That's right, and it seems to be that

21 as you -- the plant ages and these efforts are undertaken and

22 so on and so forth, and the SSFIs took place in the early '90s

23 and so on and so forth, it's an encouraging trend.

24 I think we are getting to the point where, probably,

25 most of this design -- original design defects are not there

1 anymore. There will be always some, and we cannot eliminate
2 those.
3 MR. LOCHBAUM: That was the end of addressing the
4 criticisms, so far, at least in the presentation.
5 I'd like to turn now to some of the information we
6 gathered as we researched the report that didn't -- wasn't in
7 the final report, but we think that this information supports
8 the conclusions that we drew in the report.
9 This is an NRC study -- I forget the exact date --
10 it's on the isolation condenser system reliability at boiling
11 water reactors.
12 This is a figure showing the unreliability for the
13 systems from actual plant events compared to what the IPE
14 results were for -- that were used for these various plants,
15 and you can see, for every case, the IPE result was to the
16 left of the actual plant data or actual operating experience,
17 although the error bands and the uncertainty bands did cover
18 all the data.
19 DR. APOSTOLAKIS: So, let's look at Dresden 2. Can
20 you show us -- I see the PRA on reliability. Dresden 2 is the
21 first one.
22 Where is the operating experience?
23 MR. LOCHBAUM: The last two lines are taking
24 operational experience with and without credit for recovery.
25 MR. BONACA: But that's an industry mean. I can

1 tell you it was based on data, actual data.

2 MR. LOCHBAUM: Right.

3 MR. BONACA: So, I'm saying that that's a mean down

4 there for the industry and doesn't represent, necessarily,

5 individual --

6 DR. APOSTOLAKIS: So, you don't have the operating

7 experience number for Dresden 2 in the figure.

8 MR. LOCHBAUM: Right.

9 DR. APOSTOLAKIS: I see.

10 MR. LOCHBAUM: The NRC report said not all the

11 plants had enough operational data in order to do individual

12 plant comparisons.

13 I do have some charts that do have information in

14 that regard.

15 DR. POWERS: I guess I still don't understand the

16 figure.

17 It seems to me this is a ringing endorsement of what

18 they've done.

19 The data are plotted, or the number used in the

20 analysis is plotted.

21 In some cases, they used point values, and I have

22 ugly words to say about point values, but they get used, and

23 I grow more tolerant with age, I suppose, and then you show

24 this industry mean with a range, which is good.

25 What's wrong?

1 MR. LOCHBAUM: I didn't mean to trap anybody, but
2 the next few figures, I think, will show what the problems
3 are.
4 This is the same approach applied for the
5 high-pressure coolant injection system on boiling water
6 reactors.
7 The black closed circles with the bands are the
8 operational data for each plant, with the uncertainty bands.
9 The white circles are the IPE data, without uncertainty bands,
10 and you'll notice, in this case, every single one of the IPE
11 results is to the left of the actual performance. Most -- or
12 some of the IPE data is not even inside the uncertainty bands
13 for the actual operating experience, and with this
14 unreliability curve on the axis, being to the left with the
15 IPE result means that the IPEs assumed more reliability than
16 what operational experience showed.
17 The other thing we thought was -- we noticed as
18 these curves came out was the IPEs were submitted in like the
19 '91-'92 timeframe.
20 So, they would have used -- if they used anything,
21 they would have used operational data from the '80s, early
22 '90s, which is a little bit earlier than the data used -- the
23 operational data plotted here, and everybody keeps conceding
24 that operating performance is getting better and better.
25 So, you would have expected the IPE results,

1 perhaps, to be closer to today's operational experience or
2 perhaps even to the right of today's operational experience,
3 and that wasn't the case.
4 DR. APOSTOLAKIS: I'm getting two messages from
5 this.
6 First of all, I really think that PRAs and the
7 standards that are being developed for PRAs now should insist
8 on using plant-specific data.
9 This is an excellent argument here, and we'll have
10 an opportunity to discuss this during this meeting with --
11 when we discuss the standards, because this clearly shows that
12 you have to do that.
13 I mean you really have to use plant-specific data.
14 I don't know what the basis of the other curves -- the other
15 estimates was, but clearly, it was not plant-specific data.
16 So, that's an excellent argument for that.
17 And second, again, I will come back to the point I
18 made earlier. I mean it is the NRC staff that supplies this
19 figure. It is the NRC staff that makes decisions using PRAs,
20 using the integrated decision-making process.
21 So, I would expect the staff to raise this issue if
22 a particular licensee comes, say, like Dresden, with a number
23 that is way down to the left and say, no, this is not
24 acceptable, I mean you have to do something or your PRA is not
25 very good.

1 So, that is the right context, in my mind, of this
2 figure, which I think is very enlightening.
3 MR. LOCHBAUM: I think what concerns us about this
4 data -- these reports are put out by the NRC's Office of
5 Research, and it seems like they go up on a shelf without the
6 rest of the NRC staff relying on those, because when we talk
7 about these numbers to the regions, about why Nine Mile Point
8 seems to have more trouble with RCSI, they've never heard of
9 this stuff.
10 DR. POWERS: You're preaching to the choir.
11 DR. APOSTOLAKIS: You are telling the truth, David,
12 and this committee has expressed disappointment many times
13 that a lot of the results from the former AEOD do not seem to
14 be used. I think that's an excellent point.
15 MR. LOCHBAUM: I got one. Okay. I'm on a roll now.
16 I guess I don't want to -- since I'm on a roll, this
17 is some more data. This is the reactor core isolation cooling
18 system for boiling water reactors.
19 I think this is even more striking than the last
20 chart in that seven of the 30 results or plants that are
21 reporting, the uncertainty bands for the IPE data don't even
22 overlap at all with the uncertainty bands for the actual
23 operating experience data.
24 In none of the cases do the upper end uncertainty
25 bands for the IPE data match the mean for the operational

1 experience data.

2 So, again, there seems to be a very strong bias
3 towards using IPE results that are more reliable than actual
4 operating experience would show.

5 Now, those are boiling water reactor examples. It's
6 totally different on the pressurized water reactor side,
7 totally different.

8 This is the same -- I blew it up a little bit.
9 That's why it doesn't -- it's right out of the figure, but
10 this is the auxiliary feedwater system reliability study that
11 the NRC issued, and you can see that it's totally different,
12 because the NRC put the unreliability axis on the vertical
13 axis.

14 So, instead of being to the left or right, it's
15 above or below.

16 There is one case for design class 4 where the
17 operational data -- the IPE data is actually below the
18 operational experience data. In all of the other cases, it's
19 the same as the boiling water reactor data. The IPE data is
20 shown to be more reliable than the operational experience
21 data.

22 And I agree with you, the bias can be handled as
23 long as the staff recognize that and handles it right. What
24 we're concerned about was the controls or the standards or how
25 the NRC makes that -- how it factors that into its regulatory

1 decision-making process.

2 Once we saw the system bias or what we perceive to
3 be a system bias, we wanted to try to figure out why that was
4 happening, and we haven't conclusively determined why that's
5 happening, but we think -- we eliminated one suspect, and that
6 was that, you know, these biases being introduced at the
7 component level and then just being rolled up into the overall
8 system reliability number.

9 So, this is a chart -- and there's about six or
10 seven different charts in this NRC report. This is component
11 level for the turbine-driven feed pumps -- turbine-driven
12 pumps, not necessarily feed pumps. It's the probability of
13 failure on demand, and you can see there, you have the
14 operational experience, and then you have what the individual
15 plants reported, and it's some above, some below, which is
16 what you would expect if best estimates were used or realistic
17 data was used.

18 So, it didn't seem that the bias was being
19 introduced at the component level. It was being introduced
20 somewhere else.

21 In eliminating one candidate, we didn't identify
22 what it was, but what we think it is, but we can't prove, we
23 think it's somehow related to this, and this figure appears
24 in every one of these NRC research reports, perhaps a little
25 bit easier to read.

1 It's got three round things. Region A is all
2 inoperabilities that are reported by license event reports.
3 Region B is the ones that have been -- of those
4 inoperabilities that have been classified as failures, and
5 region C, the smaller of the round things, is the ones that
6 have been -- failures that have been considered countable, and
7 I think, you know, if the industry has a different definition
8 for region C than the NRC does, then that could explain why
9 the bias at its system level, because a component-level
10 failure could be perceived as not causing the system to not
11 do its function.
12 If the NRC uses a different definition than the
13 industry, then that could explain the two curves or the two
14 -- the results being so disparate, and again, going back to
15 your comment, that doesn't necessarily mean it's wrong. It's
16 a bias that has to be recognized and factored into a
17 decision-making process.
18 What our concern is, is while the research is
19 cranking out report after report identifying and classifying
20 and labeling this bias or these differences, the rest of the
21 NRC staff isn't accounting for that in its decision-making
22 process, and that's why, in our report, we didn't say this was
23 the wrong road for the staff or the industry to be on; we
24 thought that those standards, those controls needed to be done
25 before anymore progress was made down this path. I mean that

1 seemed to be an important part that was not in the right order
2 in our mind.
3 MR. BONACA: Probably I'm not the person to answer
4 that question, but the question I would have is, has the NRC
5 asked the licensees why there are these biases? I mean, here,
6 in the test, it implies there have been calculations done
7 using raw data and using actual operating experience and using
8 data from the IPEs, and I'm not sure there has been a
9 communication back and forth to understand where this bias
10 trend comes from.
11 DR. POWERS: I guess maybe this is the point to
12 interject an issue that comes up here, and I'm not being
13 critical of your use of the IPE, because I think I'm very
14 sympathetic, in fact, using the IPE results. That's all you
15 have.
16 The situation is, the NRC asked the licensees to
17 conduct the IPE studies. They didn't ask them to use PRA.
18 In many cases, the analyses that were done to support the IPE
19 submissions were the first attempts to do a PRA of that plant,
20 and the intentions of the NRC was not to have the licensee do
21 a very rigorous, careful PRA analysis. It was to familiarize
22 themselves with the vulnerabilities of their plant and to gain
23 some experience in the area, and so, they didn't review them
24 in exhaustive detail.
25 The question that comes up, I think that gets raised

1 by all of this, is if we use a risk assessment, which now is
2 rigorous and carefully reviewed as part of a licensing action,
3 and the public has an interest in that particular licensing
4 action, how do they routinely get access to these PRA
5 analyses?
6 Well, clearly, one way is to put them on the docket,
7 but if you put them on the docket, you ossify them, and it
8 becomes -- and that almost defeats the purpose of having them,
9 and so, the question I put to you is, have you thought of any
10 way to make these PRA results accessible to the interested
11 parties without ossifying them?
12 MR. LOCHBAUM: We've thought about it a little bit,
13 because we are on the outside trying to get at information,
14 and the IPEs themselves are very large, but there are summary
15 sections and tables that basically provide the bottom line to
16 the results fairly quickly, and I think you could have that
17 on the docket, the summary and the results and the basic
18 description of the approach taken and a brief description of
19 the methodology, without having all the component failure
20 data, tables, and all that stuff on the docket.
21 DR. POWERS: The problem I see with that is that it
22 doesn't take a genius to figure out how to make bottom lines
23 look very, very supportive of one position or another, and in
24 fact, in the regulatory actions, you very seldom use those
25 bottom lines, and the regulatory actions tend to be

1 insensitive to them.

2 In 1.174, you use that bottom line number to
3 position yourself on a horizontal axis, which is plotted in
4 a log scale, so being a factor of 2 or 3 one way or another
5 hardly makes a difference at all.

6 It is the differentials of those results that get
7 used in deciding whether they're licensing actions, and those
8 differentials have to -- you now have to plunge in the
9 details.

10 Almost, I'm willing to give people the bottom line
11 results that they come back with. I can almost guess the
12 number that they'll come back with.

13 What I'm looking for is vulnerabilities in the
14 system, and those vulnerabilities are discovered only by
15 plunging into the details.

16 MR. LOCHBAUM: I guess the other answer to that
17 question would be, if the NRC had some standards or controls
18 over the methodology that plant owners did, inputs, so on, and
19 had some -- so that the NRC's methodology was publicly
20 available and the NRC's verification that plant owners met or
21 exceeded those standards, then I'm not sure that the public
22 needs -- or even I -- I wouldn't want full access to
23 everybody's PSA.

24 I want, and I think the rest of the public wants,
25 some assurance that the NRC is making sure that people making

1 decisions on risk analysis -- that those risk analysis is a
2 solid foundation for making those decisions, and I think
3 there's -- either make the risk assessments and all the
4 attendant details available or make the NRC's role in
5 verifying that that's good, make that publicly available, and
6 that might be the easier of the two or the more proper of the
7 two paths.
8 DR. APOSTOLAKIS: One of the fundamental points, I
9 think, that needs to be made here is that the decision-making
10 process that utilizes PRA is, as you know, an integrated
11 process.
12 As Regulatory Guide 1.174 describes it, there are
13 five inputs to the process, and four of them are really
14 traditional deterministic considerations, like preservation
15 of the defense-in-depth philosophy, safety margins, and so on.
16 So, in that context, it seems to me that your
17 criticism in the report acquires a different flavor. It's not
18 in the report, though. In the report, you just mention in
19 passing the risk-informed initiative on page 22, giving it one
20 paragraph.
21 You give the impression that decisions rely -- you
22 use the verb "rely" too many times -- rely on PRAs, and surely
23 you're aware of the fact that decisions do not rely on PRAs.
24 I mean it's just one input, and we have figures with shades
25 of gray, we have long discussions in Regulatory Guide 1.174

1 about model uncertainty, about sensitivity studies that
2 sometimes drive the industry crazy.
3 So, do you think that perhaps you did not present
4 the actual decision-making process as accurately as you could
5 have?
6 MR. LOCHBAUM: I think I understated it.
7 DR. APOSTOLAKIS: You understated what?
8 MR. LOCHBAUM: The reliance on the risk assessments.
9 DR. APOSTOLAKIS: You think you are relying too much
10 on risk assessments?
11 MR. LOCHBAUM: In certain cases.
12 I think the recent example is Indian Point 2, the
13 Inspector General's report on how the staff handled that steam
14 generator inspection, where the NRC staff thought that the
15 whole thing was of low safety significance and just basically
16 put it up on the shelf.
17 That wasn't made by any of these five factors and
18 weighing all this information. This was based on one person's
19 shooting from the hip, deciding that something didn't warrant
20 further NRC resources.
21 So, I think there are two many cases like -- even
22 one case like that's too many, and I think that's not the
23 isolated case.
24 DR. APOSTOLAKIS: So, we should be vigilant, then,
25 to make sure that what we call risk-informed approach is

1 actually risk-informed and not risk-based. You're saying
2 there are examples where the decision was risk-based, and that
3 was inappropriate.
4 MR. LOCHBAUM: Well, it was considered -- that
5 decision, technically, was considered risk-informed, because
6 all factors were done, but one of them was given 99 percent
7 of the weight, and the other four added up to maybe like 1
8 percent.
9 So, that was, technically, risk-informed, but it
10 really -- it was an abuse --
11 DR. APOSTOLAKIS: -- a mis-application of the
12 intent.
13 MR. LOCHBAUM: Right.
14 DR. APOSTOLAKIS: But a broader issue, though, is
15 the following, in my mind.
16 One -- and I've said that in many other contexts,
17 not just in the context of your report, because many times
18 we've had staff come here and give us a million reasons why
19 a risk-informed approach to a particular issue is not
20 appropriate.
21 People take the PRA and they scrutinize it to
22 extreme detail in the absolute.
23 They say, well, gee, you know, there are all these
24 problems, therefore you can't use it. It seems to me that's
25 the wrong way to approach it.

1 The way to approach it is to ask yourself, I have
2 now a deterministic system in place. Am I better off if I
3 supplement what I'm doing there by using risk information or
4 not?
5 That's really the proper context to evaluate the
6 PRA, and you can apply that to specific issues.
7 For example, you raised the issue of design issues
8 that have not been found and so on, and well, if I decide not
9 to use PRA, does the existing system do a better job
10 identifying those design issues, and if I use a PRA, do I have
11 a better chance of finding them and evaluating them in the
12 proper context, and I think you can practically pick any of
13 the issues you raise, and if you place it in that context --
14 now, you probably reach a different conclusion from mine, but
15 I believe that the system is better if it blends both.
16 I grant you that there may be exceptions where
17 people mis-use the process. You know, it's a big agency
18 handling many, many situations. I mean we're all human. But
19 I think that's the proper context, and just to say, gee, PRA
20 has all these deficiencies, therefore it should not be used,
21 is really an evaluation in vacuum.
22 PRA is not proposed as a methodology that will
23 replace the existing system. It will add information to it.
24 I was wondering what your thoughts were on that.
25 MR. LOCHBAUM: I agree with that.

1 Again, if we thought PRA was the wrong tool to be
2 using, or if it was going to replace the deterministic, the
3 recommendations would be to stop and fix the standards. It
4 would be just stay where you are and stop wasting all those
5 resources. But that wasn't the conclusion we reached in the
6 report. We said fix the problem.
7 I think where we see the problem is that, in the
8 example being risk-informed regulation or risk-informed
9 inspection, clearly the industry leaders in that approach have
10 looked at plant-specific inspection results, identified areas
11 where inspections are not finding problems, and have prudently
12 chosen to redirect those resources into areas where the
13 problems are being found, and to me, that's a perfect example
14 of what you explained about deterministic and now factoring
15 in risk information to be smarter, do things better, and we
16 attended some of those meetings and thought that was fine.
17 Our concern is, without the standards that the NRC
18 applies, there are other plant owners who didn't spend all the
19 time to really understand the subtleties of the issues that
20 the leaders have done, just are going to get on that highway
21 and go down the same road and might make the wrong decision,
22 and the NRC, by not having established standards, doesn't have
23 the proper tools or infrastructure to prevent those subsequent
24 abuses.
25 You know, the first -- South Texas and

1 commercial-grade classification or whatever -- those guys
2 spent an awful lot of time and an awful lot of effort to make
3 sure they fully understand it.
4 So, it's not the leaders, it's the ones that then
5 jump on the highway down the road, and we're concerned that
6 NRC's not policing against those.
7 DR. APOSTOLAKIS: Have you had the chance, by the
8 way, since you mentioned the standards, to look at the ASME
9 standard, and would you care to make a comment or two about
10 it?
11 MR. LOCHBAUM: I haven't looked at the ASME
12 standard. I have looked at NEI's -- what is it -- 0002?
13 DR. APOSTOLAKIS: The industry certification
14 process.
15 MR. LOCHBAUM: The peer review process.
16 We talked earlier about the need for using
17 plant-specific data.
18 NEI's peer review process does include that, if --
19 depending on what grade you're trying to get your risk
20 assessment classified as.
21 I forget whether 1 or 4 is good or bad, but if
22 you're just trying to use it for run-of-the-mill --
23 DR. APOSTOLAKIS: Four is good.
24 MR. LOCHBAUM: Okay.
25 If you just want a grade 1, you don't have to use

1 plant-specific data. So, there is recognition for things like
2 that.
3 The one criticism we have at this point -- it's
4 preliminary review, because I only got the thing Monday --
5 DR. APOSTOLAKIS: Sure.
6 MR. LOCHBAUM: -- so I haven't -- is that those
7 checklists, the things that have to be looked at, while
8 they're very thorough, they seem more like inventory checks
9 than they are quality checks.
10 You know, the example we could cite would be -- you
11 could ask the captain of the Titanic if you have life-boats,
12 and that answer would be yes. If the question was, do you
13 have enough life-boats for all passengers and crew, that's a
14 different answer.
15 So, they seem to me more questions of the first
16 category than the second.
17 DR. APOSTOLAKIS: There was an example of that in
18 Greece last week.
19 DR. SEALE: Two examples.
20 DR. APOSTOLAKIS: What do you think of this idea of
21 grades?
22 MR. LOCHBAUM: Well, I think the whole concept of
23 having -- I don't think very plant owner needs to have the
24 same standard risk assessment, it depends on the application,
25 and that, again, goes back to your point about -- you know,

1 deterministic base is one thing. If you opt for more and more
2 risk insights, then you should have a stronger foundation for
3 supporting those moves.
4 So, I don't think you have to have -- it's a
5 one-size-fits-all approach, and it makes sense that there
6 should be varying degrees.
7 Whether it's grades or -- you know, the actual
8 mechanism for classifying that is -- I don't have a strong
9 comment on, but I think it is good to have those tiers and to
10 be used in that way.
11 DR. APOSTOLAKIS: As long as the tiers can be
12 defined clearly, so everybody agrees, right?
13 MR. LOCHBAUM: The concern we have also goes back
14 to the old SALP process, where they -- there were tiers in
15 that approach, too, but they seemed to be somewhat subjective.
16 If the NRC thought you were a good plant owner, you tended to
17 get a 1, and if they thought -- if you were in the regulatory
18 dog-house, you got a 3.
19 So, we're trying not to get the peer review or any
20 risk assessment grade also be a reflection of how much the NRC
21 likes you.
22 That fondness should not be a factor in the overall
23 result, whether it's a grade or anything else.
24 DR. APOSTOLAKIS: You make a statement in your
25 report which I find strange, and I'm not sure that -- and I'm

1 curious to see how you would react to that.

2 On page 21, you say, "But it is not possible to
3 properly manage risk when only reasonable instead of all
4 possible measures are taken to prevent and mitigate events
5 unless the probabilities and consequences are accurately
6 known."

7 Are you seriously proposing that all possible
8 measures be taken? I mean what does that mean? You know, as
9 you know, this is a very ill-defined concept, all possible.
10 I mean we don't do that with automobiles. We don't do it with
11 airplanes.

12 Is this an exaggeration to make a point, or should
13 it be taken literally?

14 MR. LOCHBAUM: It can be taken either way. It is
15 true, if you take all possible measures, then it doesn't
16 really matter to know what the probability or consequences of
17 any event are, because you're doing everything that's
18 possible, and those risk insights wouldn't change what you're
19 doing, because you're already doing everything you can.

20 I wasn't advocating doing everything that was
21 possible.

22 DR. APOSTOLAKIS: I see.

23 MR. LOCHBAUM: The point I was trying to make --
24 I've had several comments on this paragraph. The comments I
25 had were from people who didn't like risk assessments at all,

1 and they were conceding that things could be done. They
2 thought I understated the point.
3 But what I was trying to say is, if risk insights
4 are then being used to draw a line between what you do and
5 what you don't do, then you need to understand the
6 consequences and the probabilities well enough to draw the
7 line and decide not to do things that are on the wrong -- on
8 one side of the line, and that was the point I was trying to
9 make, and it clearly didn't come across, because I've had
10 several comments on that.
11 DR. APOSTOLAKIS: I have one last question. Looking
12 back the last 25, 30 years, do you think that the use of risk
13 information has made plants safer or not?
14 MR. LOCHBAUM: I think it has. I think the IPE
15 program itself identified vulnerabilities and led to several
16 real changes, not paperwork changes, actual plant
17 modifications or procedure changes to improve safety.
18 I think the extension of that effort was the
19 maintenance rule. A lot of that research or activity led into
20 the maintenance rule.
21 I think the maintenance rule -- the emphasis on both
22 the safety system reliability and also what were traditionally
23 considered BOP systems and the increased attention on those
24 has led to overall safety improvements.
25 So, I'm not saying that risk insights have been a

1 net loss. There clearly have been some gains, and important
2 gains.
3 DR. APOSTOLAKIS: Do any of my colleagues have any
4 comments or questions?
5 DR. POWERS: I'm still coming back to the access to
6 information.
7 One of the studies -- PRA studies that was fairly
8 extensive that is publicly available was the reactor risk
9 reference study.
10 MR. LOCHBAUM: Is that in NUREG-1150?
11 DR. POWERS: I think that's 1150.
12 MR. LOCHBAUM: Yes.
13 DR. POWERS: Did you consult that at all in
14 preparing this document?
15 MR. LOCHBAUM: In earlier discussions over the last
16 year, as this report was being researched, we referenced 1150
17 quite a bit, and NEI was the obligatory counterpoint on each
18 of those arguments, and it was that 1150's out of date, and
19 you really need to understand the inputs that drove the
20 numbers, you can't just rely on the end points, which is what
21 I had been doing when I was citing 1150. So, we decided to
22 go back and look at the individual IPEs to try to respond to
23 that criticism.
24 So, that's why we didn't use 1150 in this report,
25 although we were aware of it and had used it previously.

1 DR. POWERS: Well, the upshot of that is that your
2 report now harkens back more to the old WASH-1400 and Army
3 studies and things like that, which are really geriatric. I
4 mean that's when the technology was really in the
5 developmental stage, I would say. So, you end up abandoning
6 one study, because it's out of date, in favor of some that are
7 really old.
8 DR. SEALE: A whole array of studies --
9 DR. POWERS: -- that are really old.
10 MR. LOCHBAUM: That's true.
11 DR. SEALE: And again, the quality control, if I may
12 use a phrase, the legal authority for the IPEs was not what
13 we would expect for any PRA that we would use today. It was
14 vulnerability identification, and we all know that you can do
15 a risk assessment which can be very coarse in certain areas
16 and very fine in other areas to identify particular
17 vulnerabilities.
18 DR. POWERS: I think that's especially true when
19 you're trying to look for vulnerabilities that you don't know
20 about.
21 DR. SEALE: That's right.
22 DR. POWERS: And you say, okay, well, gee, I know
23 that I'm vulnerable in this particular area, in my piping
24 system, so I'll just put in some numbers there, because I
25 already concede that point, I'm looking for something else,

1 and so, you do strange things on your inputs there.

2 DR. KRESS: If I boil this down to a few words, it

3 seems to me like your problem is that NRC doesn't seem to have

4 good quality standards that it enforces in PRAs and that PRAs

5 are shortcoming in that they don't deal with latent design

6 defects.

7 If we had those two things fixed and the movement

8 towards risk-informed regulation, I think you might be in

9 favor of.

10 MR. LOCHBAUM: That's basically our conclusion. You

11 know, those standards need to be there and enforced, and then

12 the move to risk-informed regulation would be -- could be a

13 good thing.

14 Not every plant owner is going to do that, but those

15 objections would be removed.

16 DR. SEALE: Yeah, but then again, you run into the

17 same problem again.

18 Suppose you want to look at the difference in two

19 alternatives, and those two alternatives could be very

20 specifically defined.

21 Now, I can do that within the context of a very

22 detailed, highly formalized, high QA, overall PRA, perhaps

23 even levels 1, 2, and 3, and the whole school yard, or I can

24 do a modified PRA process which treats those particular detail

25 differences in considerable detail, and the rest of it rather

1 coarsely, and come up with a number that may not be valid in
2 terms of actual risk for the overall plant but will tell me
3 that the difference in risk between this alternative and that
4 alternative is a factor of whatever.
5 Now, under certain circumstances, if that's to
6 determine how I'm going to conduct a maintenance process and
7 what equipment I will have in service and what equipment I
8 won't have in service, then clearly, the focused assessment
9 tells me all the answer I need to know to make that decision.
10 MR. LOCHBAUM: Well, conceivably, both of them
11 could.
12 DR. SEALE: Yeah, but one of them is so long to do
13 that I won't have the answer when I need to do the appropriate
14 maintenance, or it's so expensive that I don't have the people
15 on the floor to do the work, I have them in the PRA group
16 doing the assessment.
17 MR. LOCHBAUM: I agree with that, because again
18 comparing it to what we're doing today, in 50.59, you have to
19 make a determination like that, if a modification or a
20 procedure change or configuration affects the margin of
21 safety, and you have to do some evaluation, whether it's
22 PRA-based or not PRA-based.
23 DR. SEALE: Yeah.
24 MR. LOCHBAUM: So, if the approach that's selected,
25 whichever of those two is done, meets or exceeds the decision

1 that would have been made to the old non-PRA 50.59, then
2 either of those approaches should be acceptable.
3 DR. SEALE: Yes.
4 MR. BONACA: I have a question regarding those two
5 plots you showed, HPCI and unreliability, and the question I
6 have is, did you find these trends consistently for other
7 systems, or are these the grossest examples?
8 MR. LOCHBAUM: Every volume that I received from the
9 research that was sitting on my desk had this trend. The only
10 one I didn't use was the reactor protection system study that
11 recently came out for B&W and Combustion Engineering, because
12 I didn't see a plot in there like this. I think there was
13 some text to that effect, but there wasn't a plot, and I tried
14 to illustrate with a plot.
15 So, it wasn't that I only picked the ones that
16 supported my argument.
17 MR. BONACA: Okay. So, the trend is there, you say.
18 Okay.
19 MR. LOCHBAUM: I didn't look at all the reliability
20 studies, but the ones that were on my desk that I received
21 recently, I did, and every one of them supported it.
22 MR. BONACA: One thing we found -- and I'm not sure
23 this is the answer to the problem -- when we reviewed the
24 experience of station blackout, we found that -- the NRC found
25 that the industry and the NRC were counting unreliability a

1 different way, and that was because regulation in different
2 forms allows different ways of counting, and I'm just
3 wondering -- because I mean, this consistent bias seems to be
4 -- you know, certainly is a concern.
5 MR. LOCHBAUM: That's why I think it's some of an
6 accounting system, because if it was a methodology or if it
7 was a personnel problem, people just weren't getting all the
8 data, then I would expect to see some plants perhaps to the
9 right of the operational data, whereas there seems to be a
10 fairly consistent bias for all plants, all methods. So, I
11 think there's something more generic than just --
12 DR. APOSTOLAKIS: On the good side, of course, the
13 same office issued reports that showed that the frequencies
14 of initiating events were, in fact, over-estimated in some
15 instances by the PRAs.
16 So, it would be, in fact, interesting to find out
17 why these things are happening and whether it was just a
18 matter of judgement or accounting or whatever.
19 So, the evidence is mixed.
20 But the main message that the PRAs we're using now
21 should reflect this experience I think is a good one.
22 MR. BONACA: That's the most troublesome part to me,
23 that there are these biases, and we don't know why.
24 DR. APOSTOLAKIS: We can investigate that.
25 Any other questions from the members? Comments?

1 [No response.]

2 DR. APOSTOLAKIS: Does the NRC staff have any

3 comments that they would like to make?

4 MR. BARRETT: I'd like to make a few comments.

5 DR. APOSTOLAKIS: Please identify yourself first.

6 MR. BARRETT: My name is Richard Barrett. I'm Chief

7 of the PSA -- Probabilistic Safety Assessment branch in the

8 Office of Nuclear Reactor Regulation.

9 I just would like to make a few comments based on

10 what I heard today, and I think, to some extent, I'm repeating

11 what some of the members had to say.

12 I believe there's a lot in this report that we would

13 say is technically correct.

14 I think there are some things in this report that

15 we would take issue with, technically, but I think primarily

16 what we would be concerned about is the implication that PRAs

17 have not been used in a judicious fashion by the staff in our

18 decision-making process.

19 We feel that, throughout the history of the use of

20 PRA by the NRC, which goes back 25 years, we've been very

21 cautious in using it, and we have used it with full knowledge

22 of the weaknesses, limitations, and uncertainties in the

23 methodology.

24 There are some, like myself, who have felt that we

25 could have been much more aggressive over time, but here we

1 are now 25 years after the Rasmussen study and we're now
2 moving into an arena where we are beginning to use PRA in a
3 way that will challenge the methodology.
4 I think that what you'll find, though, is that, in
5 our decision-making process to move into risk-informing Part
6 50, both option 2 and option 3, we are taking into account a
7 lot of the lessons learned from our own experience and some
8 of the ones that are pointed out in the UCS study, and we feel
9 that we have defined -- and I would refer everyone to SECY
10 00-162, which I think is an excellent description of the
11 decision-making process that we tend to use, because SECY
12 00-162, what we say is that it's the quality of the decision
13 that counts, not the quality of the PRA.
14 PRA -- as with Reg. Guide 1.174, PRA will be used
15 in conjunction with other methodologies, with other sources
16 of information, and with other consideration. We will look
17 at generic PRA results, as well as plant-specific PRA results.
18 We will look at the results of deterministic studies, and we
19 will also look at considerations of defense in depth and
20 safety margin.
21 And having looked at all of those, the staff will
22 decide what trade-offs have to be made between quality of the
23 analysis that's submitted and the quality and depth, scope of
24 the staff's review of individual applications.
25 We know that PRAs, in the past, have had their

1 weaknesses. I think my favorite example in the UCS report is
2 the discrepancies between the Wolf Creek and Calloway plant,
3 because Wolf Creek and Calloway were standard plants, designed
4 to very similar specification, and yet, they not only had
5 different numerical results, they came up with different
6 dominant contributors.
7 We know that, today, those two PRAs have very
8 similar results both in the numerical results and in the
9 dominant contributors, and the reason for that is that there
10 has been an effort over time on the part of the owners groups,
11 on the part of those licensees to compare the results, to
12 compare the plant designs, and to find out what are the
13 reasons for these discrepancies.
14 Now, you could say that, over time, these groups,
15 working together, have converged on the same answer, possibly
16 not the right answer.
17 We believe that the opposite is true, that these
18 efforts to compare the bases of these PRAs and to challenge
19 each other through these peer processes actually leads to more
20 correct answers.
21 So, we believe that, over time, this peer
22 review-type of process will give us better PRAs, PRAs of
23 higher quality.
24 We are currently reviewing the industry's peer
25 review process, and we know that, in fact, the peer review

1 process does ask the question, how many life-boats you'd have
2 to have on the Titanic, not just whether or not you have any,
3 but we've asked the industry to document so-called sub-tier
4 criteria, asked them to document them so that it's not only
5 clear to the NRC staff but it's also clear to our other
6 stakeholders, and we think that's important.
7 I think I agree with the assertion that the UCS
8 study had to be done on the basis of IPE results, because
9 that's all the results that were available, and I think, as
10 time goes by, we're going to see more and more information
11 available on the public record.
12 A couple of specifics:
13 With regard to the use of --
14 DR. POWERS: Let me interrupt you on that point.
15 You're persuaded we don't have to do anything special here,
16 that this is just a natural evolution, we're going to have
17 publicly available data that would allow people like Gary to
18 make comparisons that didn't have this question of whether
19 he's comparing data that nobody would stand behind or
20 something like that?
21 MR. BARRETT: I don't want to speak for the
22 industry, and perhaps someone from the industry would like to
23 speak, but there has been a lot of discussion on the part of
24 the industry, and I think, to some extent, motivated by the
25 UCS report, to make a lot more information available, publicly

1 available in a scrutable way so that more accurate public
2 discussion of these PRAs can be held.
3 I won't say anymore than that, but maybe the
4 industry would like to say something.
5 I'd like to speak to a couple of specifics.
6 One is the use of the operational experience reports
7 that were published by EOD, now published by Research.
8 We in NRR get those reports in draft form, we review
9 them. We are aware of the results, and we use the results,
10 as applicable, in the reviews of license amendments and other
11 regulatory actions.
12 I'm not familiar with this particular view-graph
13 about the high-pressure coolant injection systems. I am
14 surprised to see that it indicates the unreliability of this
15 safety-related system is in the 30- and 40-, even as high as
16 70-percent range for BWRs in this country. I think my
17 recollection of the report was that -- and the other
18 operational data reports -- was that the unreliability of most
19 of the systems on a train basis is in the few-percent range,
20 not the few-tens-of-percent range.
21 This may not be representative of the bottom line
22 of these operational experience reports.
23 The other thing I'd like to point out is that we are
24 using -- the example of Indian Point was brought up, and I
25 think that we now have a couple of examples of how

1 risk-informed regulatory action has been taken in the review
2 of inspections like the Indian Point case.
3 I would point you to the Farley case and the ANO
4 case, and in those two cases, one of which we approved a
5 licensee continuing to the end of the cycle and one in which
6 we did not approve it, the full risk-informed Regulatory Guide
7 1.14 process was used, and I think that, if you review those
8 two SERs, you'll get an example of what happens when this
9 risk-informed thinking is applied.
10 So, in summary, I'd like to say we do see a lot of
11 things in the UCS report that we agree with. We think that
12 PRAs have to be continuously improved.
13 We also think that there is a limit to how much they
14 can be improved. We have to have a regulatory process that
15 accounts for these limitations.
16 We think that, in the past, we've had such a
17 regulatory process. We're committed to having such a
18 regulatory process in the future.
19 DR. APOSTOLAKIS: Comments?
20 MR. LOCHBAUM: My recollection on the Farley and the
21 ANO uses of Reg. Guide 1.174 is Farley was approved before the
22 IP-2 accident and ANO was denied after the IP-2 accident. If
23 those were flipped, I'd question very strongly whether the
24 approval/denial would have been reversed.
25 I think it's more a function of the accident at IP-2

1 than the technical merits of the two cases, but I could debate
2 that till the cows come home.
3 DR. APOSTOLAKIS: Any other comments from the staff?
4 Dr. Parry?
5 MR. PARRY: This is Garth Parry from NRR.
6 I just want to make a kind of clarification about
7 the use of the IPE results in the significance determination
8 process.
9 There are two points to be made here.
10 The first is that the IPEs were taken primarily as
11 the first step and that the process then is to send that out
12 to the licensees, who will review it, together with NRC staff
13 and contractors, to reflect the most up-to-date results, but
14 I think the more important thing about the use of the IPE is
15 that the results that are being used, the significance
16 determination process, are probably among the more robust
17 results from the PRA in the sense that all that's being used
18 is the structure of the event trees in terms of the systems
19 and functions that are required to respond to the different
20 initiating events.
21 I think I've made this statement before in front of
22 this committee that I think those results are unlikely to
23 change very much.
24 The IPEs differ largely in the level of detail and
25 in the numerical results, which are not directly used in the

1 SDP process, and remember, too, that the SDP process and the
2 way that the work-sheets are used is really only a screening
3 tool.
4 It's not the last word. It's just intended to be
5 a conservative screening tool to act as a filter.
6 MR. LOCHBAUM: I'll look into that, but this is the
7 site-specific work-sheet that went out to Indian Point 2,
8 dated January 3rd of 2000. The pages aren't numbered, so I
9 don't know which page it is, but it says that the human error
10 probability assessed in the IPE, page 3-371, is 5.62E to the
11 minus 2.
12 So, you know, it seems to be more than just
13 structure and things like that.
14 MR. PARRY: Yeah, I'll make comments on that, too.
15 In the very original SDP process, effectively, human
16 error probabilities were given a choice of .1 or .01 across
17 the board, depending on an assessed level of stress, and I
18 think we've designed it that that really isn't appropriate,
19 because in fact -- take boiling water reactors as an example.
20 Every sequence ends with initiating suppression pool
21 cooling.
22 If we gave that a 10 to the minus 2, then every
23 transient would turn out to be -- any change that related to
24 a transient would turn out to be a red, which really doesn't
25 make any sense, so it defeats the object.

1 So, what I think is underway is that we're trying
2 to get all the results on the AGPs from the suite of IPEs
3 that's out there, and on the basis of that, a conservative
4 estimate for a particular function will be chosen to represent
5 the screening tool.
6 So, yeah, the plant-specific numbers are in there,
7 but they're being used at the moment as -- they're just being
8 collected.
9 DR. APOSTOLAKIS: Any other comments from the staff?
10 [No response.]
11 DR. APOSTOLAKIS: Any comments from the public?
12 [No response.]
13 DR. APOSTOLAKIS: Hearing none, thank you very much,
14 Mr. Lochbaum.
15 MR. LOCHBAUM: Thank you.
16 DR. APOSTOLAKIS: Back to you, Mr. Chairman.
17 DR. POWERS: Thank you, Professor Apostolakis.
18 You've given me an extra 15 minutes that, alas, I cannot use,
19 so we will have to take a -- we will recess until a quarter
20 after 10.
21 [Recess.]
22 DR. POWERS: Let's come back into session.
23 We're going to continue our discussion of PRA with
24 an examination of the industry PRA peer review process
25 guidelines, and again, I'll turn to Professor Apostolakis to

1 provide leadership in this area.

2 DR. APOSTOLAKIS: Thank you, Mr. Chairman.

3 We have at the table Mr. Fleming and Mr. Bradley,

4 who will take the lead in this.

5 I have a question before we start, because -- and

6 it's probably a naive question, but in the Executive Summary

7 of NEI 00-02, it says that one desired outcome of having a PRA

8 review process is to streamline regulatory review of

9 risk-informed applications.

10 In other contexts, we've said that, you know, this

11 would expedite reviews, will make the life of the staff

12 easier, of the industry, of course.

13 If that is the case, why do you need the NRC to

14 approve anything?

15 I mean if you have a process that you think will do

16 that, won't that happen de facto?

17 I mean the NRC will have to review, no matter what,

18 whatever submission is made.

19 Now, if you follow a process that you think is

20 reasonable, then the NRC staff naturally will do this in a

21 more efficient way.

22 Why do we need to go through this painful process

23 of getting the blessing of the NRC in advance?

24 Do you anticipate that there may be a situation

25 where a licensee comes in there and say, oh, my peer review

1 certification process which you have approved, let's say, says
2 that this PRA is grade 3, so you should accept it's grade 3.
3 I mean, clearly, that cannot be the case, because the staff
4 will still have to review it.
5 So, I don't know why we have to go through this and
6 have the staff approve anything.
7 I mean isn't it de facto, something that will happen
8 de facto?
9 MR. BRADLEY: Okay. I'll try to answer that.
10 I think we will attempt to answer that in more
11 detail in today's presentation.
12 What we requested was a specific NRC review with
13 regard to option 2 of the Part 50 regulatory reform effort,
14 and maybe I'll just go ahead and put my first slide up, since
15 that's on there anyway.
16 We've had discussions with the staff regarding the
17 use of the peer review process to facilitate review, focused
18 NRC review of applications for some time now, and there have
19 been continuing questions about aspects and details of the
20 process.
21 Submitting the process for NRC review was intended
22 to give NRC the opportunity to look at the process in detail,
23 ask the questions they need to, and basically try to achieve
24 the comfort level we believe they need in order to
25 successfully use this process for regulatory reform and

1 provide focused NRC review based on their knowledge of the
2 process itself, as well as what we'd have to submit in terms
3 of the option 2 application.
4 So, it was specific.
5 You're right, it's going to be somewhat of a painful
6 process.
7 We've already gotten the first RAI, and I know what
8 South Texas feels like now, and we'll have to kill a few trees
9 to respond to that, but we believe it's a necessary thing that
10 we need to go through, and it puts it in the public record,
11 and it's, you know, for everyone there to look at.
12 DR. APOSTOLAKIS: But the question is, do you expect
13 -- let's say that you finally agree on something, you know,
14 you modify your process, the NRC staff is happy, and so on.
15 Do you expect that the licensee may come to the
16 staff and say, look, the supporting documentation went through
17 the peer review process, which you guys have approved,
18 therefore you should accept it, or is the staff going to
19 review it anyway?
20 MR. BRADLEY: No, we're not asking for some type of
21 carte blanche acceptance based on the fact that it's been
22 peer-reviewed.
23 We're asking for a focused -- using that result, to
24 focus the review and streamline the review, not to obviate the
25 review.

1 DR. APOSTOLAKIS: So, that is my question.

2 MR. BRADLEY: Right.

3 DR. APOSTOLAKIS: If that is the case and you do a
4 good job, is there any need for -- okay. The staff passes
5 judgement now and you say, well, gee, we really would like to
6 see that, too, and leave it at that, without asking them to
7 actually bless this.

8 MR. BRADLEY: I think both pieces are necessary.
9 Given the nature of PRA, we're trying to get at this from all
10 possible directions and establish a successful framework to
11 get applications to go forward.

12 So, it seemed appropriate to put this on the docket
13 and get NRC to have a look at it.

14 MR. FLEMING: If I may add to what Biff said, I
15 think another motivation for that statement that George is
16 referring to is the fact that, if utilities follow the
17 certification process -- and that identifies strengths and
18 weaknesses in their PRA -- those strengths and weaknesses can
19 be addressed in the application, and as part of the
20 application process, as it's submitted to the NRC, that
21 information can be presented as a way to build confidence that
22 strengths and weaknesses in the PRA have been identified and
23 they've been addressed for that particular application.

24 DR. POWERS: But the NRC staff will have to make
25 that determination anyway.

1 So, if you have done it already, the staff will
2 breeze through it and say this is good.
3 Why is there a need for the staff to bless the
4 process in advance?
5 I mean they will just see the results of it and say,
6 gee, those guys really know what they're doing, and then after
7 they do that three or four times, they will start saying, oh,
8 yeah.
9 I mean if they submit a grade 3, chances are we'll
10 review it very quickly.
11 MR. BRADLEY: I guess our view is, if NRC is
12 familiar with the process, if they've reviewed it and have
13 confidence in it, that will make it that much easier. I mean
14 that might be a leap to expect them to be able to reach that
15 kind of conclusion if we haven't asked them to review the
16 process.
17 DR. APOSTOLAKIS: But you're not expecting that
18 somebody will come in here and say this is grade 3, you have
19 approved it --
20 MR. BRADLEY: That's correct.
21 DR. APOSTOLAKIS: -- therefore we need an answer by
22 Monday.
23 MR. BRADLEY: That's correct. That's not what we're
24 asking for.
25 We recognize -- I mean, if regulatory reform

1 succeeds, we're going to get a fairly large number of
2 applications in process concurrently, and we have to have some
3 method to use NRC's resources in an efficient way to approve
4 those, and we're all trying to achieve some reasonable middle
5 ground as to how we can do that, and this is part of that.
6 DR. SIEBER: Is it a factor that the NEI document,
7 by itself, is not a mandatory thing for utilities to use, and
8 therefore, they could pick and choose whether they would use
9 it at all or what parts they would use by having some kind of
10 regulatory blessing that provides the incentive to use it all
11 the way it stands?
12 Would that be part of the reasoning?
13 MR. BRADLEY: I guess I never thought of that as
14 part of the reason.
15 I don't know, Karl, if you want to elaborate, but
16 I guess I'm not aware of utilities that are just using
17 portions of it.
18 I mean we have funded through the owners groups the
19 application of the process to essentially all our plants by
20 the end of next year, and it's the whole thing. It's the
21 whole process.
22 DR. SIEBER: Okay.
23 MR. FLEMING: It may be a rather moot point, because
24 all the owners groups have committed to completing a peer
25 review process, and we're more than halfway through all the

1 plants in the country applying it.

2 MR. BRADLEY: Why don't we go ahead and try to start

3 here?

4 I have taken the bold step of putting a fair amount

5 of detail in Karl's presentation, and I guess we may beg the

6 committee's indulgence to maybe let him try to get through as

7 much of that as possible.

8 We did want to give you a pretty good sense of how

9 the peer review process can be used to support an application,

10 and that's what Karl's presentation is going to get at. I

11 just wanted to set him with just a few brief remarks here on

12 -- and I think we already covered some of them.

13 We are talking about a specific application here,

14 option 2 of the Part 50 regulatory reform effort. NEI has

15 developed a guideline which we've given to the staff for

16 review on that whole process.

17 It's an integrated decision process. It's sort of

18 a classic 1174 application. It also uses sensitivity studies

19 and other methods to -- as part of the process to check the

20 overall result and the categorization.

21 Therefore, the use of the PRA in that application

22 is specific, and there's specific things about a PRA that are

23 important for that application.

24 DR. APOSTOLAKIS: NEI 00-02 doesn't say that it's

25 only for --

1 MR. BRADLEY: No, no, no. 00-02 was developed for
2 broader use.
3 DR. APOSTOLAKIS: Isn't that what we're reviewing
4 today?
5 MR. BRADLEY: We want to talk to you about how we
6 want to use 00-02 to facilitate NRC review of option 2.
7 That's what we're going to talk about today.
8 We've already briefed the committee a number of
9 times on the general process of 00-02 or the peer review
10 process, and wanted to move beyond that today and talk about
11 specifically how we would focus the NRC review of option 2.
12 DR. APOSTOLAKIS: Well, I have some specific
13 comments anyway.
14 MR. BRADLEY: Okay. That's what we're intending to
15 do.
16 These are some of the slides we've used in some of
17 our recent discussions with the Commission and with our own
18 working group at NEI.
19 We do believe that a peer review will always be
20 required, that you can never reach a point where you can have
21 a checklist that would give you the necessary information to
22 use a PRA for an application without any further advanced
23 review.
24 DR. WALLIS: What is the second bullet here? What
25 do you mean by that?

1 MR. BRADLEY: That there is a certain amount of
2 engineering judgement inherent in the process.
3 DR. WALLIS: Well, I'd say there's judgement in how
4 extensive it needs to be or how much evidence you need, but
5 it's not judgmental. It's based on evidence. It's based on
6 scientific reasoning. It's not inherently judgmental.
7 MR. BRADLEY: Well, there are some judgmental
8 aspects.
9 MR. FLEMING: I think what we meant by that -- and
10 maybe the choice of words could have been refined -- is that
11 PRA is not a tangible, measurable type of thing, it's based
12 on a state of knowledge, and of course, the state of knowledge
13 --
14 DR. WALLIS: All science and engineering is,
15 obviously.
16 MR. FLEMING: Right.
17 DR. WALLIS: That's the kind of remark I would have
18 expected from UCS.
19 MR. BRADLEY: Well, I'm not UCS.
20 DR. WALLIS: I'm sorry. You'll have to clarify what
21 you mean by a statement like that.
22 DR. APOSTOLAKIS: I think the word "inherently" is
23 a bit too strong.
24 DR. WALLIS: Much too strong.
25 MR. BRADLEY: The point we were trying to make here

1 is that, regardless of what requirements you write into a
2 standard or to a process, that you need a peer review of a
3 team of experts to look at it.
4 DR. WALLIS: Well, let me try this. If I said the
5 thermodynamic analysis is judgmental in the sense that you
6 have to use judgement in how far you're going to go in detail,
7 that's true, but it's not inherently so. It's inherently
8 scientific.
9 MR. BRADLEY: Okay.
10 DR. WALLIS: Is that what you mean? That's what you
11 mean, isn't it?
12 MR. BRADLEY: Yeah.
13 DR. WALLIS: Okay.
14 DR. SHACK: What you mean is that you don't believe
15 you can do a design to PRA standard. Is that what it means?
16 MR. FLEMING: Yes, I think that's what it means, and
17 I'd just amplify on it.
18 The "judgmental" refers to the fact that, right off
19 the bat, to select the initiating events for a PRA model
20 involves many, many judgements about what's important, and
21 those judgements are inherent into the process of selecting
22 initiating events.
23 DR. WALLIS: Well, that's inherent in the
24 thermodynamic code. I mean how much detail are you going to
25 go into?

1 MR. FLEMING: But in a thermodynamic code, at least
2 I can design an experiment to go out and benchmark my computer
3 code against some actual measurements.
4 DR. WALLIS: You can do that with PRA if you have
5 enough time.
6 DR. POWERS: What you say is perhaps true, but since
7 no one ever has enough time, I think the distinction has to
8 be drawn here.
9 But maybe, Karl, it would help if you gave us a few
10 examples of where this judgement has to be made, because
11 clearly, I could say things in a standard like, you shall use
12 plant-specific data for the reliability of valves, okay. I
13 may not want to, but I could.
14 MR. FLEMING: I think where this comment was heading
15 is that, no matter what you write in a book in terms of
16 criteria for performing a PRA, a standard for a PRA, or a
17 process for doing a review, it requires expertise to perform
18 the PRA and to review the PRA, and no matter what you put in
19 there, judgements will have to be made about whether the
20 state-of-the-art has been applied in an appropriate way.
21 So, it's just an acknowledgement of that, and I
22 think it's more important than the thermodynamic example --
23 I have to take issue with that -- because the quantities that
24 we calculate in a PRA, core damage frequency, are not
25 observable quantities. The temperature of a mass is an

1 observable quantity.

2 So, we don't have the scientific ability of

3 experiment to match up the theory to the same extent we had

4 with thermodynamics.

5 DR. APOSTOLAKIS: I think there is a place in the

6 PRA where judgement is crucial, and this is in the collection

7 of data, where you have to decide whether a particular

8 occurrence in a failure or not.

9 You really need experienced analysts to declare that

10 something is a failure or not, especially when you go to

11 common cause failures, you know, whether that failure applies

12 to your plant and so on, as Karl knows very well.

13 So, I think this is a judgement that you don't

14 really find in other more deterministic --

15 DR. SEALE: PRAs are probabilistic, but they're not

16 actuarial.

17 DR. APOSTOLAKIS: They're not actuarial, and again,

18 they agree that the word "inherently" perhaps was too strong.

19 I mean there is always an element of judgement. So, let's go

20 on.

21 MR. BRADLEY: I think I've already covered this

22 slide.

23 Basically, what we're asking for with option 2 and

24 with any application is the ability to focus NRC's review.

25 We also -- I want to make the point that -- as

1 you'll see, I think, in Karl's presentation, the peer review
2 process does elucidate the areas in a PRA that need
3 improvement to support an application, and we're going to
4 illustrate how it does that and what some of the improvements
5 that have been made in some PRAs are as a result of peer
6 reviews, but we do recognize that a number of the existing
7 PRAs will need improvements to support the option 2
8 application.
9 We've already provided the NRC staff with the
10 schedules for the upcoming peer reviews.
11 They're being conducted by all four owners groups,
12 and we believe the process itself, in order to understand the
13 process and appreciate its value, it's not simply reviewing
14 the process guidance, it's a dynamic process, and it's a very
15 intensive process involving the team and the plant site and
16 includes preparation prior to the review and meetings every
17 day and a final interaction between the peer review team and
18 the utility.
19 And the whole process -- it really needs to be
20 observed to be appreciated, and we've extended the invitation
21 to NRC staff to observe some of these upcoming reviews, and
22 I'm going to extend that same invitation to the members of the
23 committee, if they're interested. The staff is working now
24 with the schedules, and you know, please let them know if
25 you're interested in observing.

1 We strongly believe this is a credible, good
2 process, and we want as many people as possible to get out
3 there and observe it firsthand.
4 DR. APOSTOLAKIS: Could you have a Heisenburg effect
5 here?
6 MR. BRADLEY: Well, at some point, that's possible,
7 you know, if we had 20 observers.
8 There obviously are some practical limitations, but
9 we certainly would work with the schedules we have and with
10 the interest to facilitate as many people as we could.
11 Another thing we recognize is that the process right
12 now is a one-time review, although there are a few sites that
13 have been through or will go through it twice, but in order
14 -- there may be a need to develop a closure mechanism to
15 address, one, whatever deltas may come out of the NRC review,
16 if there's a belief that certain technical elements need to
17 be improved or whatever, or if there are substantial
18 improvements made to a plant PRA.
19 There may be cases where you need to do a second --
20 some type of a streamlined peer review to help close that
21 loop, and we're looking at mechanisms that might be available
22 to do that.
23 Also, with regard to facilitating NRC review of
24 option 2, ISI is the example we use. We're going to have 78
25 units coming in to apply for risk-informed in-service

1 inspection over the next two years.

2 I mean that is, by far, the most successful of the

3 optional type applications we've achieved yet, and in order

4 to have NRC review that many applications, we developed a

5 template for the review, and that template includes a summary

6 of your results, as well as a discussion of the peer review

7 results and what improvements you may have needed to make to

8 the PRA to allow you to do the ISI application.

9 DR. APOSTOLAKIS: As you say repeatedly in the

10 report, you don't give an overall grade. You grade individual

11 elements.

12 MR. BRADLEY: Right.

13 DR. APOSTOLAKIS: So, when the licensee comes for

14 an ISI application, then the licensee submits the PRA and

15 says, look, for the elements that are really important to ISI,

16 the peer review process ended up with the highest grade. For

17 others, where the grade is lower, they are not really that

18 relevant to this particular application.

19 I can see that happening, but I don't see a licensee

20 coming in here and saying the result of the review process is

21 that, for this element, we got a low grade, and that's

22 important to ISI.

23 Is that correct?

24 MR. BRADLEY: That's correct.

25 DR. APOSTOLAKIS: Okay. So, it's for the elements

1 that are not relevant to the particular application where a
2 lower grade would be tolerated.
3 MR. BRADLEY: That's right.
4 DR. APOSTOLAKIS: Okay.
5 DR. WALLIS: Can you explain the third bullet?
6 MR. BRADLEY: The template?
7 DR. WALLIS: That sounds to me as if you're telling
8 NRC what to do.
9 MR. BRADLEY: No.
10 What we want to do is work with the staff, just like
11 we did on ISI, to find what elements are important to their
12 review of the application and make sure that we can capture
13 those in a streamlined practical way, and remember, NRC set
14 out to implement option 2 with no advance review, which I
15 think is an incredibly ambitious undertaking, and I guess
16 industry's view is that that's really not feasible, that there
17 will have to be some review.
18 Obviously, the entire detailed documentation,
19 models, and everything else are going to be available for
20 inspection and assessment.
21 DR. WALLIS: Doesn't NRC develop its own templates
22 in the form of standard review plans and things like that?
23 MR. BRADLEY: This is simply a review template.
24 This isn't an inspection template or anything else. This is
25 a template where we can agree with the staff that, if a

1 licensee puts this set of information into the application,
2 that will help NRC to be able to do an expeditious review.
3 That's all we're trying to achieve here.
4 DR. WALLIS: This is a question, perhaps, of getting
5 the words right, but it doesn't look right, as if you're
6 developing a template which looks as if you're telling NRC
7 what to do.
8 MR. BRADLEY: No.
9 Finally, the -- in listening to Dave Lochbaum's
10 presentation, there was quite a bit of discussion of the need
11 for updated risk information, and industry is aware of this
12 need.
13 I don't think it serves us to have to continually
14 defend studies of IPE results that are 12 years old, and
15 really, we've moved well beyond those for the majority of
16 plants, and there are two elements I think we're looking at.
17 One is, for those plants that actually would
18 undertake regulatory reform, like an option 2 application,
19 we're looking at developing some type of summary description
20 that would go into the FSAR for that plant, because at that
21 point, you really are putting the licensing basis more firmly
22 into a risk-informed arena, with option 2 or option 3, for
23 that matter, and those plants, we believe, would need to
24 develop something along those lines, and so, we're working
25 with that as part of the option 2.

1 Now, there's another question of general industry
2 risk information and making summary information available for
3 all plants, you know, in terms of updating the type of
4 information that's out there for the IPEs now, so that there's
5 publicly available, current risk information.
6 We're not talking about docketing the models or
7 anything but coming up with some reasonable high-level summary
8 that we could -- probably in some kind of matrix form or
9 something.
10 And those are the two things we're looking at now
11 as an industry to try to get updated risk information to the
12 forefront.
13 I think of the -- you know, I would agree that all
14 the stakeholders would be served by having more current
15 information.
16 DR. APOSTOLAKIS: So, when you say that this is to
17 support the implementation of option 2, essentially you're
18 talking about the classification of components --
19 MR. BRADLEY: Yeah.
20 DR. APOSTOLAKIS: -- risk 1, 2, 3, 4, which
21 essentially means Fussell-Veseley and risk achievement worth.
22 Okay.
23 But the first bullet also asks the ACRS to comment
24 on the whole document, not just option 2.
25 I mean you have briefed us before, but we never

1 really reviewed it as such.

2 MR. BRADLEY: If you want to comment on the

3 document, that's great, and I'm sure you will, but what we're

4 really asking for here is your interest in observing the

5 actual process.

6 DR. APOSTOLAKIS: Okay. That clarifies it.

7 MR. BRADLEY: Okay.

8 At this point, I'm going to turn it over to Karl,

9 and he's going to go into a little more detail about how we

10 would -- I guess the other thing I'd mention is we haven't yet

11 sat down and developed all the details of how the option 2

12 review template would work, but we have done for other types

13 of submittals that we're doing now, such as tech spec AOT

14 extensions, and we're going to talk about just using that as

15 an example to show how we're thinking here.

16 DR. SHACK: Will the peer review results be publicly

17 available in any sense?

18 MR. BRADLEY: The peer review results -- to the

19 extent that you make an application for, say, an option 2 or

20 ISI or whatever and you go on the docket with a summary of

21 your strengths and weaknesses and how you disposition those

22 to support the application, the answer is yes.

23 Whether we would docket the -- you know, the lengthy

24 detailed peer review report, probably less likely we would do

25 that, although at this point, we are still looking at the

1 level of detail of information, but I think the answer is
2 generally yes, in some form.
3 MR. FLEMING: What I'd like to do in the next few
4 minutes -- I apologize for the volume of material in the
5 hand-out package.
6 When I was warned about having too much material for
7 an ACRS presentation, I told my colleagues at ComEd that I
8 wasn't ambitious enough to believe that I would get through
9 all my slides, even if I had a single slide, but I did want
10 to kind of point out some examples of how recently, especially
11 in the ComEd case, how very recently the certification process
12 was used to help support a specific application, and the
13 purpose of this is to try to bring out, I think, a better
14 understanding of how the industry or at least one element of
15 the industry plans on using this process and maybe clear up
16 some possible misconceptions that I think may have arisen on
17 the certification process.
18 So, in this particular example, we're talking about
19 the processes that apply to ComEd.
20 A few things that I wanted to point out -- I don't
21 want to go into the details. I know you've had the NEI 00-02
22 report to review. Just a few key highlights I wanted to bring
23 out.
24 I've been involved personally on six of these
25 certifications, three on the BWR side and three on the PWR

1 side, but in this particular example I'm going to go through,
2 I was on the end supporting the PRA team and using
3 certification findings done by others.
4 But what these consist of is a team of six,
5 sometimes seven people who spend about two to three person
6 months total reviewing the PRA documentation in a very
7 structured process.
8 They do homework, quite a bit of homework before the
9 actual site visit, and they probably spend a good 60 hours in
10 actual on-site review at the site.
11 DR. APOSTOLAKIS: Does this include a walk-down?
12 MR. FLEMING: Yes. There is a focused walk-down
13 made by a subset of the team to look at specific issues that
14 have come up in the PRA.
15 What's important to understand is that there's a
16 very structured process. I mean every minute of every day of
17 the on-site review session is structured in terms of
18 identifying assignments for different people to take the lead
19 on different parts of the review, and what's also important
20 to recognize is that there is a very important set of products
21 that are produced in the certification team, and I want to
22 make a little bit of a comment about the certification team
23 itself.
24 The certification teams that are being put together
25 include at least one or two people who are recognized experts

1 in PRA that a lot of you would probably have seen in the PRA
2 community before but, importantly, include members of the same
3 owners group utility PRA staffs, which provides some very
4 useful features of the certification process.
5 One of them is that the people that are
6 participating on these reviews know plants, and they know
7 plants of the same owners group vintage that is being
8 reviewed, and they bring into the certification team insights
9 from their plants in terms of the plant features that are
10 important to risk, as well as the features that they brought
11 from their overall PRA program.
12 So, they leave on the doorstep of the certification
13 process recommendations on how the PRA could be enhanced, and
14 they also have a capability of going in and finding
15 weaknesses, especially in the area of looking at the plant
16 fidelity -- the plant model fidelity issue, and I think that's
17 very important.
18 You can have people that are very, very experienced
19 in PRA come in and not really know the plant very well and not
20 necessarily do a fruitful review.
21 For each -- in the process that we come up with,
22 there's a grading system, 1 through 4. There's a lot more
23 information in the report for that.
24 This grading process is an important part of the
25 certification process, but it's not the most important part,

1 and I think its uses maybe have been somewhat overstated.

2 What really is the most valuable aspect of the

3 process, from my point of view, and all the people that are

4 participating on these, is a detailed set of fact and

5 observation forms that identify the strengths and weaknesses

6 of the PRA.

7 These are very, very specific issues that the team

8 comes up with that are put into different classifications of

9 priority.

10 The most important categories are the A and B

11 categories, which could have a significant impact on the PRA

12 results.

13 Category A are recommendations for immediate

14 attention and update of the PRA before it's used in

15 decision-making.

16 Category B are other issues that are considered to

17 be important but could be deferred until the next update.

18 The C issues are issues that probably don't impact

19 the baseline PSA results but could be important for specific

20 applications.

21 Category D issues are the ones that are basically

22 editorial comments that are recommendations for cleaning up

23 the documentation, and a very, very important category is

24 category S, where the team is identifying particular

25 strengths, where this particular element of this PRA is

1 recognized as an industry leader in that type of an activity.
2 DR. WALLIS: This is like the inverse of the
3 academic grade. I mean A means bad and D means good.
4 MR. FLEMING: That's right.
5 DR. WALLIS: It's a bit unfortunate.
6 DR. APOSTOLAKIS: They keep their distance.
7 MR. FLEMING: That's right. It probably reflects
8 the fact that so many of us have been so long out of school.
9 DR. WALLIS: Don't come round saying all the plants
10 got A's, therefore it's good.
11 MR. FLEMING: That's right.
12 Now, the other --
13 DR. LEITCH: Before you move too far away from the
14 certification team, it seems to me that there's a measure of
15 subjectivity in this peer review and that that subjectivity
16 is largely tied up in the team.
17 Is the team always independent of the plant that is
18 being evaluated?
19 MR. FLEMING: Yes. There are requirements for
20 independence, and as part of the documentation for the peer
21 review is basically an affidavit, a statement by each team
22 member, who identifies his independence from the PRA team.
23 Now, there have been a few cases where a particular
24 team member has been involved, for example, in the level 2
25 aspects of the PRA, where that person basically excuses

1 himself from any of the consensus sessions, and that's a
2 reality, is that if you force -- if you want to force too much
3 independence, you may not have adequate expertise to do the
4 review.
5 DR. LEITCH: Yeah.
6 MR. FLEMING: So, there have been a few exceptions
7 like that, but there's an affidavit, a statement made in the
8 documentation, a declaration of independence or a declaration
9 of whatever involvement they did have, so it's on paper and
10 documented, and that's part of the process.
11 DR. LEITCH: The other side of independence, as you
12 point out, is having an adequate knowledge base, and you
13 obviously need people that are well versed in the issues. So,
14 it's kind of a two-edged sword.
15 MR. FLEMING: That's right.
16 In the formulation of the team, there's quite a bit
17 of effort that goes together by the owners group chairman --
18 for example, Barry Sloan on the Westinghouse owners group,
19 takes the lead on that, and Rick Hule on the General Electric
20 one, and so forth -- to make sure that the specific team that
21 has been put together covers all the expertise needed to
22 review the elements of the PRA.
23 DR. LEITCH: Might a particular BWR, though, have
24 a set of six or seven people that are totally different than
25 those that are evaluating another BWR, or would there be some

1 commonality between those players?

2 MR. FLEMING: They worked hard to have some common
3 players on the certification team to make sure that there's
4 a carry-over of consistency, and that's the main ingredient
5 that's put into the process to try to improve the
6 certification and certification consistency.

7 An important product, though, is the third item,
8 which is, having identified strengths and weakness of the PRA,
9 very specific recommendations on what could be done to get rid
10 of or to resolve the issue, and a very important part of this
11 is that, for the most important categories of issues, the A/B
12 issues on the negative side and the F's on the positive side,
13 it's a requirement that there's a consensus of the entire
14 six-or-seven-member team on these grades, because they're very
15 important.

16 We realize that we're leaving on the doorstep, in
17 the case of A and B, issues that have to be addressed, and we
18 want to make sure that it's not just the opinion of one
19 person.

20 In the consensus process and the participation of
21 Bruce Logan of INPO, for example, he recognized that to be a
22 very, very important part of this.

23 It's not just a bunch of opinions that are rolled
24 together; it's a consensus process.

25 DR. KRESS: Just for clarification, when you talk

1 about each PRA element and sub-element, just exactly what do
2 you mean by that?
3 MR. FLEMING: What I mean by that -- if you look at
4 the NEI 00-02, the PRA is divided up into -- I can't remember
5 the actual number -- about 10 or so elements.
6 Initiating events would be one, and then those are
7 further broken down into sub-elements, and there's a total of
8 209 of these, and these are just simply the elements within
9 the elements.
10 So, for an initiating event, there would be
11 sub-elements for identifying and for grouping and for
12 quantifying and frequency and so forth, and it just provide
13 -- that checklist is simply a way to add structure to the
14 process to make sure that we're looking at, you know, all the
15 same things in each one of the reviews.
16 It's not intended to be a comprehensive or complete
17 all-inclusive list, but it's enough of a structure to provide
18 some consistency for the reviews.
19 DR. WALLIS: How does this affect the uncertainty
20 in the results? It seems to me that you can keep on improving
21 the structure, keep on updating, but it doesn't mean to say
22 that the certainty or the confidence you have in the answer
23 that's being given is necessarily increased as a result of all
24 this.
25 MR. FLEMING: Well, I'm going to give you an example

1 in a second that I hope to address that, but one of the
2 elements that is looked at is quantification, and as far as
3 the confidence in the overall results of the PRA, whether they
4 make sense, that's looked at in great detail in the
5 quantification element, and if there is believed to be
6 technical issues, A and B issues, in particular, that could
7 impact the quantification, those are brought out in the
8 review.
9 I'm going to walk through an --
10 DR. APOSTOLAKIS: I have questions.
11 When you say 1 is IPE and 2 is risk-ranking, 1 means
12 identifying the dominant sequences, vulnerabilities, and 2
13 means the option 2 application?
14 MR. FLEMING: This is better explained in, actually,
15 the NEI report.
16 It's recognized that there's a continuum of quality
17 levels for each element of the PRA, and arbitrarily, those
18 were broken up into four levels, and the general definition
19 is that 1 represents a PRA that just meets the requirements
20 of the IPE, and it's just a anchor point, historical anchor
21 point to be able to take reference to what's already happened
22 in the industry.
23 A 2 means that the PRA is capable to support
24 application involving screening, you know, screening kind of
25 applications.

1 We call it ranking, but what it really means is
2 being able to screen SSEs into broad categories of high,
3 medium, and low safety significance, where you're not really
4 worrying too much about the absolute number.
5 Three is the risk significance determination, which
6 would be like a Reg. Guide 174 kind of an application, and 4
7 is something to capture, you know, a state-of-the-art level
8 treatment of the actual element.
9 DR. APOSTOLAKIS: Well, the impression I get from
10 reading the report was slightly different, that 1 was really
11 identifying -- being able to identify the dominant sequences,
12 2 was importance measures, and then 3 and 4, I agree with you.
13 MR. FLEMING: Yeah.
14 DR. APOSTOLAKIS: This is very important, because
15 if you're going to the body of the report, there are some
16 questions that are raised, and I think I should raise one now.
17 It is stated on page 9 and then on page 18 that you
18 don't need to do a time-phased analysis -- is that what they
19 call it? -- for 1. I lost the page now. In other words, if
20 you have a certain window of time and the operators have to
21 do something, that you don't need to do that if you do a 1,
22 grade 1, I guess, and then that common cause failures, on page
23 18, are not needed.
24 It says explicitly are not needed for risk ranking,
25 okay?

1 Now, the note is "not required for successful
2 ranking or dominant contributor determination."
3 Now, there was a PRA which you are extremely
4 familiar with where the number 1 accident sequence was loss
5 of off-site power, loss of all the diesels, and failure to
6 recover power within the available time before core uncovery
7 occurs. That's the number one contributor.
8 If I am not -- I mean I don't know how you lose the
9 diesels there, but I'm sure common cause failure played a
10 role.
11 If I don't do common cause failure analysis and if
12 I don't do this time-dependent human probability for recovery
13 of power, I will never be able to identify this dominant
14 sequence.
15 So, my grade 1 and 2 will really not give a
16 reasonable result, unless I go to 3.
17 MR. FLEMING: Yeah. I don't have the document in
18 front of me, but I think that may reflect a poor wording in
19 the document.
20 I can assure you that, if someone came and presented
21 a PRA for the certification process that didn't model common
22 cause failures, they could not get a grade higher than 1.
23 DR. APOSTOLAKIS: Well, it's very clear in the note.
24 MR. FLEMING: Okay.
25 DR. APOSTOLAKIS: "Not required for successful

1 ranking or dominant contributor determination."

2 MR. FLEMING: Okay. Well, yeah, I can't account for

3 that.

4 DR. APOSTOLAKIS: Do you remember, perhaps, where

5 the definition of the grades is given in the document?

6 MR. BRADLEY: I think if you could let us proceed,

7 you'll -- what we're trying to make the point here is that

8 we're not trying to hinge the review on the grades, and all

9 this discussion of the grades is really a little bit

10 tangential to our intent here of trying to show how we're

11 going to use the process, certainly not our intent to go in

12 and say I got a grade X and therefore it's okay.

13 That's not how we're doing this, and obviously,

14 things like common cause and time dependencies are going to

15 be important for most applications that we're going to apply

16 this to.

17 But I think if you could possibly let Karl proceed,

18 we might answer some of these questions.

19 DR. APOSTOLAKIS: Well, it seems to me that this is

20 such an explicit instruction here -- it says there is a note,

21 "not required for successful ranking or dominant contributor

22 determination," and here is a major plant where the number one

23 sequence involves these things. I mean that's a little

24 troublesome, isn't it?

25 MR. FLEMING: Well, I can assure you that it is

1 required.

2 In the certifications that we're doing, if you would
3 come in with a model without common cause failures in it, it
4 could not get a grade higher than 1, and 1 is just a lower
5 bound that the system -- we don't have a zero. Probably, we
6 should get a zero in that case.

7 I can't explain this particular aspect of the
8 document, but the document is a problem, and I can't recall
9 seeing a PRA that does not have common cause failures of
10 diesels modeled. I don't think there's any out there.

11 So, I don't know whether this is really an
12 operational issue or not. The document may have some flaws
13 in it.

14 What I'd like to do now is to basically walk through
15 a little case study of how, at the ComEd Byron and Braidwood
16 stations, this certification process was used in an actual
17 successful application, and if I can walk you through the --
18 in this particular case study I wanted to walk you through,
19 back a few years ago, ComEd decided that they want to pursue
20 a risk-informed application involving a 14-day diesel
21 generator AOT, and that was done in conjunction with a
22 decision to upgrade their PRAs, to take into account advances
23 in PRA technology and design changes since the original IPEs
24 were done.

25 So, they're in the process of doing a major upgrade

1 to the PRA, and they also had decided to pursue a Reg. Guide
2 177-style submittal to request a 14-day extension on the
3 diesel generator allowed outage time.
4 So, the Westinghouse owners group certification was
5 scheduled for September 1999.
6 That was scheduled during the period of the PRA
7 update, and it was scheduled, actually, to provide an
8 opportunity to get some input while the PRA upgrade was being
9 actually completed, and then what happened was that, on the
10 basis of the fact and observations, strengths and weaknesses
11 that were identified during the Braidwood certification, there
12 was a continuing process of upgrading the PRA, and then, in
13 September of 1999, there was a submittal to the NRC staff
14 requesting diesel generator AOT extensions for both Byron and
15 Braidwood.
16 Byron is a sister plant to Braidwood, and the PRA
17 models are very similar, but there are differences, as well.
18 In the submittal itself, it was a Reg. Guide
19 177-style submittal.
20 There was information submitted to summarize the
21 updated PRA results, and there was also a representation that
22 a certification process had been done to support the basis for
23 the quality of the PRA supplied in the application.
24 After that and while the NRC was in the process of
25 reviewing the submittal which was made in -- actually, the

1 submittal was actually made in January 2000, this year. Later
2 on, in the summer of this year, there was a followup
3 certification on the Byron plant, and that was -- provided a
4 special opportunity, since the Byron and Braidwood PRAs were
5 being done concurrently, because of the similarities in the
6 plant.
7 There was an opportunity for basically the same
8 certification team to come back and take a look at how the
9 issues identified for Braidwood had been resolved that applied
10 to Byron, as well, which was essentially 98 percent of them,
11 and at the same time provided sort of a confirmation that the
12 strategy taken by ComEd to resolve the technical issues that
13 came up had been satisfactorily addressed, and that was
14 reflected by a significant improvement in the results of the
15 certification process.
16 DR. APOSTOLAKIS: Now, when you say Braidwood was
17 doing a PRA, what do you mean? They were doing what you and
18 I would understand as a PRA?
19 MR. FLEMING: Right.
20 They were in the process of upgrading their PRA from
21 soup to nuts, you know, converting the software, going back
22 over the initiating events, constructing new event trees,
23 success criteria, the whole aspect, and as you may recall, the
24 original IPEs submitted for the ComEd plants were subjected
25 to a lot of issues associated with a very different set of

1 success criteria and so forth.

2 So, there was just a lot of background in terms of

3 lessons learned from the original IPE process that ComEd

4 wanted to take advantage of, and they basically have

5 completely updated all the PRA programs at all five of their

6 plants.

7 DR. APOSTOLAKIS: So, they were not upgrading their

8 PRAs, the parts of the PRA that they felt would be useful to

9 this particular application. They were upgrading the PRA,

10 period.

11 MR. FLEMING: Well, they were upgrading the -- I'm

12 glad you mentioned that.

13 They were upgrading the PRA for a range of

14 applications that they had planned to pursue, which included

15 risk-informed tech specs, included risk-informed ISI, included

16 supporting their configuration risk management program, and

17 others.

18 DR. APOSTOLAKIS: Okay.

19 MR. FLEMING: So, they did have a specific package

20 of applications that they wanted to pursue, but the first one

21 -- the first like Reg. Guide 174 application that was launched

22 as a result of this upgrade was the diesel generator case.

23 DR. APOSTOLAKIS: So, would you say, since you are

24 very familiar with the process, that they were coming close

25 to having a category 2 PRA of the ASME standard?

1 MR. FLEMING: I'm going to get to the details of
2 that in a -- I'll answer your question in a second, if I might
3 indulge -- have your indulgence on that.
4 Now, what happened was, in the course of the NRC
5 review of the diesel generator tech spec submittal, they asked
6 for some additional information on the results of the
7 certification process, and as a result of that, ComEd
8 submitted a summary of the category A and B issues, the ones
9 that were given the highest priority, together with what had
10 been done to address each one of the issues, and that then led
11 to the final completion of the NRC review, and just recently,
12 the NRC has issued the safety evaluation report granting the
13 risk-informed tech spec.
14 So, that's sort of a synopsis of how the process was
15 used, and I want to get back into some insights came through
16 the overall process.
17 What's been happening here is that it sort of
18 illustrates in one particular case study that a decision had
19 been made to use the PRA, a certification process was
20 identifying specific strengths and weaknesses of the PRA, and
21 through this overall process, there were a number of
22 risk-management insights that -- we can argue about
23 certification processes and standards and things like that,
24 but the bottom line is that the risk-management process was
25 working and working very well.

1 The two big issues that had been identified in the
2 Byron and Braidwood PRA -- one involved vulnerability due to
3 internal flooding scenarios in the auxiliary building, where
4 there was a possibility of floods that would take out the
5 safety-related service water pumps located in the basement of
6 the aux building, and loss of service water, of course, was
7 a very serious event at this plant, Westinghouse plant, which
8 would lead to a reactor coolant pump seal LOCA problem.
9 The other issue was that there was a very large
10 contribution due to reactor coolant pump seal LOCAs, and the
11 first insight was that, actually through Westinghouse's -- I'm
12 sorry -- through ComEd's participation on the Westinghouse
13 owners group certification process, they became aware of
14 different strategies that were being used by different
15 Westinghouse plants to reduce the risk of reactor coolant pump
16 seal LOCAs.
17 And they actually decided to implement one of these
18 changes, which has to do with providing a way to use the fire
19 water system to provide an alternate component cooling pathway
20 for the charging pumps so that, in the event that you would
21 lose service water and you had the charging pumps available,
22 you could maintain a path of seal injection.
23 It turns out that a very large number of the
24 Westinghouse plants have been using, you know, techniques like
25 this to reduce the probability of the conditions for the pump

1 seal LOCA sequence.

2 So, the actual -- you know, the participation in the
3 certification process actually led to this insight, led to a
4 decision to change the plant design and improve the risk with
5 respect to this aspect.

6 The second one was that plant modifications were
7 made to address the internal flooding issue, which was the
8 dominant contributor in the PRA reviewed by the certification
9 team, and plant modifications were identified to also reduce
10 this risk contributor.

11 The other thing that was discovered through this
12 process was that, in going through the evaluations required
13 by Reg. Guide 177 and Reg. Guide 174, the risk metrics that
14 we were using to evaluate the acceptability of the 14-day
15 allowed outage time turned out to be not affected by either
16 the flooding risk or the modifications that were put in place,
17 and what was a little bit difficult about this application was
18 that ComEd was in the midst of managing the risk of flooding,
19 managing the risk of reactor coolant pump seal LOCA during the
20 course of making this submittal to the NRC.

21 Another risk-management insight that we found was
22 that, when we tried to calculate the incremental risk metrics
23 that Reg. Guide 177 calls for for evaluating tech specs, we
24 discovered that just a straight application of those risk
25 metrics led to problems meeting the acceptance criteria.

1 And that led to insights back into the PRA to
2 determine insights from the configuration risk management
3 program on what compensatory measures needed to be taken while
4 you're taking a diesel generator out of service to be able to
5 justify risk acceptance criteria being met, and as a result
6 of this process, it was determined that the risk acceptability
7 or the risk insights that bear on the question of
8 acceptability from this overall process actually was dictated
9 by how the plant configuration was managed during the 14-day
10 diesel generator outage time, and these insights were actually
11 reflected in the license amendment request and in the NRC
12 safety evaluation report.
13 Now, how did the -- just want to talk a little bit
14 -- how did the certification impact all of this, and this
15 happens to be a roll-up of the grades that were obtained in
16 the original Braidwood IPE or PRA review process, and as noted
17 in NEI 00-02, there's grades given at the sub-element and
18 element level but not on the overall PRA.
19 This is a rack-up of what grades were given by the
20 team for each of the elements of the PRA.
21 The parentheses (c) means that the grade level 3 was
22 provided under specific conditions that specific issues that
23 came up in the PRA were identified, and those issues are
24 identified in the specific fact and observation sheets that
25 are sort of tallied here in this table.

1 So, the overall flavor of the certification review
2 process was that they either got 3's or condition 3's but the
3 conditions were conditioned on very, very specific issues that
4 the certification team took issue with that didn't think were
5 quite adequate for supporting the application.
6 MR. BRADLEY: So, that would be conditional on those
7 being resolved.
8 MR. FLEMING: Yeah.
9 So, what this suggests here is that, you know, it
10 wasn't so much the grades themselves that were important, was
11 the specific things that had to be done to be able to support
12 the risk-informed application.
13 DR. APOSTOLAKIS: Let me understand the initiating
14 events, the first row.
15 MR. FLEMING: Right.
16 DR. APOSTOLAKIS: You have A, B, C, D, S are the
17 possible grades.
18 MR. FLEMING: No, the grades are 1, 2, 3, 4 for
19 initiating events, and what's listed in the rest of the table
20 are basically a frequency distribution of the number of fact
21 and observation issues that came up for initiating events.
22 So, a total of nine comments were made or technical
23 comments were made for initiating events by the whole group,
24 and they are distributed according to priority.
25 You know, there was one A issue, two B issues, and

1 four C issues and so forth, and each one of these is
2 documented in the form of here's the technical issue, here's
3 what we think ought to be done to resolve it, and so forth.
4 DR. APOSTOLAKIS: And what you call a grade was
5 derived from those how?
6 MR. FLEMING: The grade was derived by looking at
7 all the sub-elements, the grades for the sub-elements, which
8 I haven't showed you here --
9 DR. APOSTOLAKIS: For initiating events.
10 MR. FLEMING: -- for initiating events, the specific
11 fact and observations -- in other words, the technical issues
12 that were identified for that, and then there was -- those
13 were weighed against the overall criteria for grades 1, 2, and
14 3.
15 So, what you don't see here -- there's a big
16 detailed checklist for initiating events that has grades for
17 maybe 25 or 30 sub-elements for initiating events,
18 identification, grouping, support system initiators, and so
19 forth, and what this table simply shows is that the
20 certification team gave an overall grade for initiating events
21 of a conditional 3, meaning that, if these three items in
22 column A and B, if those issues were resolved --
23 DR. APOSTOLAKIS: If they are resolved.
24 MR. FLEMING: If they are resolved, they would
25 qualify for 3.

1 They're effectively a 2, with the path to get to a
2 3 by meeting these particular issues.
3 DR. APOSTOLAKIS: There is a 3 and a C. Three means
4 it can be used for risk-informed applications?
5 MR. FLEMING: Under conditions.
6 DR. APOSTOLAKIS: Under these conditions.
7 MR. FLEMING: Under these conditions.
8 DR. APOSTOLAKIS: And C means desirable for
9 applications? Why is the parentheses in a C?
10 MR. FLEMING: I'm sorry, that's a different C. The
11 C in the grade column simply means that there is a condition
12 on meeting the grade, whereas C in the other column means it's
13 categories -- those are different C's. I'm sorry to confuse
14 you.
15 DR. APOSTOLAKIS: So, the grade, then, coming back
16 to your second slide or so, is 3 refers to risk-informed --
17 MR. FLEMING: That's right.
18 DR. APOSTOLAKIS: -- could be used for risk-informed
19 applications --
20 MR. FLEMING: Yeah.
21 DR. APOSTOLAKIS: -- according to 1.174.
22 MR. FLEMING: And the C means that you don't get the
23 grade 3 unless you meet specific -- if you address specific
24 issues, and I'm going to give you what those issues are in a
25 second.

1 MR. BONACA: The A is significant. There is no
2 modeling of the ABG design feature, but there is a 3 without
3 a condition.
4 DR. APOSTOLAKIS: System analysis?
5 MR. BONACA: System analysis, for example.
6 MR. FLEMING: Well, in the case of systems analysis,
7 the team did not feel that the issues in this case were
8 significant enough to affect the grade of 3, but keep in mind
9 that the utility is still left with A and B issues, and that's
10 one of the points I want to get here. They're not just going
11 to stop because they get a 3. They've also got to resolve
12 their category A and B issues.
13 MR. BONACA: I think the issue -- the second issue
14 in the next table -- it was resolved.
15 MR. FLEMING: Yeah, right.
16 DR. APOSTOLAKIS: Why can't the industry do this for
17 every single unit and have a grade 3 PRA so we will not have
18 to argue about 1 and 2?
19 MR. FLEMING: I think the industry wants to get
20 there, but they want to get there along an optimal path of
21 allocating resources. They want to be able to see where they
22 are, measure where they are right now, see what kind of
23 applications they want to do this year, next year, and the
24 year after that, and they want to advance towards quality in
25 the most cost-effective strategy. I think that's what they

1 want to do.

2 DR. APOSTOLAKIS: That's my fundamental problem.
3 Can one identify the dominant contributors without having at
4 least a grade 3 PRA? That's my problem, because there is an
5 allowance for that.

6 You know, in category 1, all you're looking for is
7 vulnerabilities. Can you really do that without having a
8 level 3 PRA? That's my problem.

9 I agree with you that they want to follow the
10 optimal path and get some return for their investment on the
11 way, but it seems to me this is the baseline PRA that we
12 should have, and this process is very good.

13 MR. FLEMING: What I believe is, in this scheme, the
14 category 2, 3, and 4 all have to be able to identify the
15 dominant sequences. Category 1 is simply a historical
16 milepost.

17 DR. APOSTOLAKIS: Okay.

18 MR. FLEMING: Okay?

19 DR. APOSTOLAKIS: But again, you dismissed the
20 document earlier, but we have to go by the document, and if
21 the document says that, for category 2, I don't have to look
22 at the time calculations, like, you know, recovering AC power
23 and then I know that the PRA you managed came up with a number
24 one sequence that involved that, I'm having a problem.

25 MR. FLEMING: I think what the time comment referred

1 to in the document is the level of detail in the calculation
2 of these time-sensitive sequences.
3 In other words, in category 2, you could roll up
4 your frequency of loss of off-site power and probability of
5 non-recovery in a very simplistic time-independent model,
6 whereas for the category 3 and 4, you'd have to basically be
7 able to delineate how much was happening in the first hour and
8 second hour and third hour.
9 I mean it's a question of level of detail and
10 simplicity. It's not things that are missing.
11 DR. APOSTOLAKIS: But it seems to me that -- you
12 know, later on, we're going to discuss, also, the ASME
13 standard.
14 A lot of the disagreement comes from the fact or
15 from the apparent claim that you can do certain things by
16 doing a limited number of things for a PRA.
17 I mean if you do what you're describing here, I
18 think a lot of the controversy would go away, but that's not
19 what the documents say.
20 MR. FLEMING: The document is the document. The
21 document is part of the process, and that's one of the things
22 I wanted to try to get off in this presentation, is to walk
23 you through in a complete soup-to-nuts application to show you
24 how this is actually being used.
25 The document is one part of it. It may be an

1 imperfect document.

2 DR. APOSTOLAKIS: My problem is not what you're
3 describing, because you see you are ending up with a grade 3
4 PRA.

5 The question is, will there be other licensees who
6 will be happy with a 2 there, instead of a 3, and they would
7 demand risk-informed decisions from the staff?

8 MR. BRADLEY: It depends on what the risk-informed
9 decisions are and how you're using the PRA to support those.
10 It's conceivable there could be certain risk-informed
11 decisions.

12 We're doing it today with a number of things that
13 we're doing. You can't distill it down to a black-and-white
14 line.

15 With regard to 00-02, which you have in front of
16 you, try to look at that in the context of the letter with
17 which we submitted that to NRC, and we are asking for a review
18 with respect to a specific application and also with regard
19 to the ability to focus NRC's review using the facts and
20 observations, not to obviate their review in a specific
21 application.

22 We're trying to get this down to some pragmatic
23 thing we can do to get option 2 implemented here, and I think
24 a lot of the questions you're asking have to do more with the
25 general approach of 00-02 and specifically the four

1 categories, which were developed a long time ago, and you
2 know, we've been through this on the ASME standard ad nauseam
3 with trying to define what fits into what category, and we're
4 really trying to just sort of get away from that here with
5 regard to how we would use this in option 2. It's a specific
6 application.
7 DR. APOSTOLAKIS: I understand that, and the
8 question is, then, is the methodology required for identifying
9 the dominant sequences different from the methodology required
10 to classify systems, structures, and components, and if so,
11 why?
12 Do you require a simpler methodology to place SSCs
13 in those four groups?
14 MR. BRADLEY: It depends on the details of the
15 categorization process.
16 That's why we're asking for these things to be
17 reviewed in concert.
18 In depends on how -- where you draw the line, what
19 sensitivity studies you use, and all kinds of other aspects,
20 and how this feeds into the integrated decision process of the
21 option 2 application.
22 That's why you have to look at this in context with
23 the categorization.
24 DR. APOSTOLAKIS: And that's the problem. Can I use
25 a methodology that will miss a major accident sequence and yet

1 will give me satisfactory results?

2 MR. FLEMING: Let me see if I can address that.

3 First of all, the only of these four grades that
4 have any practical significance is grades 2, 3, and 4. Grade
5 number 1 is basically for historical reference purposes, and
6 I don't think anyone in the industry would be satisfied with
7 a grade level 1 anything in their PRA.

8 They're getting some grade level 1's at elements and
9 sub-element levels, and they're fixing those and getting up
10 at least to grade level 2, but for grade level 2, 3, and 4,
11 it is necessary to be able to identify the dominant sequences,
12 and for grade level 2, whatever else you have to have in order
13 to be able to do risk screening, and there are utilities that
14 are happy to use a grade level 2 PRA to be able to identify
15 that something is not important, to be able to say that this
16 set of motor-operated valves is definitely not important.

17 You don't have to have a lot of detailed PRA
18 information, necessarily, to be able to do that.

19 If you have enough -- a minimum threshold or
20 critical mass, if you will, to call this thing a PRA, you need
21 to be able to identify the dominant sequences and at least be
22 able to put components, SSCs, into broad categories of safety
23 significance.

24 DR. POWERS: I get the impression most people
25 understand that.

1 The question is that you do need some details PRA
2 results to do that categorization.
3 MR. FLEMING: Yes.
4 DR. POWERS: The question is which detailed ones?
5 Professor Apostolakis has found a contradiction that
6 he brings to your attention here in discussing level 1. You
7 don't want to discuss level 1, because it's meaningless now,
8 but the same contradictions are potentially available to us
9 in levels 2, 3, and 4, aren't they?
10 MR. FLEMING: I guess I don't really appreciate what
11 the contradiction is.
12 DR. APOSTOLAKIS: I followed what the document said,
13 and it specifically says, for 1 and 2, in fact -- I think it
14 includes 2, and it's a very important point, so bear with me
15 for a second. I'll find it.
16 DR. POWERS: While you're looking, I will comment
17 you're succeeding well on not getting through your
18 view-graphs.
19 DR. APOSTOLAKIS: So, on page B-9, designated AS-13,
20 time-phased evaluation is included for sequences with
21 significant time-dependent failure modes; for example,
22 batteries for station blackout, BWR RCPC LOCA, and significant
23 recoveries."
24 And then it says, for PSA grades 1 and 2, you don't
25 need to do this, and I'm telling you, the number one sequence

1 in the PRA you managed a number of years ago was this.

2 MR. FLEMING: I don't think that's what's intended.

3 DR. APOSTOLAKIS: There may be an error.

4 MR. FLEMING: There's a level of detail. It's not

5 that you don't have to include it. I think you have to

6 include it for the lower grades.

7 It's a question of whether you have to include it

8 using a time-dependent model or a simplified model. I think

9 that's what's intended for that.

10 DR. APOSTOLAKIS: Okay.

11 MR. FLEMING: That's the way we are using it.

12 DR. POWERS: You pose a challenge to understanding

13 your document, then, because a blank no longer means a blank,

14 it means kind of a blank.

15 MR. BRADLEY: I think maybe you're answering the

16 question you asked earlier about why we submitted this for NRC

17 review.

18 We'll go through this thing in detail and

19 specifically ferret out any issue that's going to impact

20 option 2.

21 DR. APOSTOLAKIS: I'm willing to accept Karl's point

22 that maybe there are some mistakes here, but the intent was

23 not to do that.

24 Now, the fundamental question in my mind is, is

25 there a difference in the methodology that identifies the

1 dominant sequences from the one that identifies the
2 significance of SSCs?
3 MR. FLEMING: No.
4 DR. APOSTOLAKIS: There shouldn't be.
5 MR. FLEMING: I don't believe there is.
6 DR. APOSTOLAKIS: You might argue that I can do a
7 cruder analysis for the classification, because I will be very
8 conservative in placing things in boxes.
9 MR. FLEMING: That's what's intended.
10 DR. APOSTOLAKIS: But in principle, there shouldn't
11 be a difference.
12 MR. FLEMING: No, there isn't.
13 DR. APOSTOLAKIS: I agree with you.
14 Dr. Bonaca.
15 MR. BONACA: I just had a question.
16 If you put back the previous slide and you take off
17 the C's, you will have a number of areas where you call it a
18 2 right now.
19 MR. FLEMING: That's right.
20 MR. BONACA: And it will be mostly 2's.
21 MR. FLEMING: Right.
22 MR. BONACA: And here it seems to me that the effort
23 required to go from a 2 to a 3 is really a minor effort, seems
24 to be, almost.
25 MR. FLEMING: Excuse me? It's a minor effort?

1 MR. BONACA: Yeah, it seems to be. I mean there are
2 a few issues -- granted, these are only the A's, but there
3 are, you know, a number of B's.
4 The question I'm having is that I could say, well,
5 this PRA was already almost a 3, had just a minor number of
6 issues that made it a 2, and I'm trying to understand what is
7 the range of quality in a grade 2, for example.
8 MR. FLEMING: Well, first of all, let me clarify
9 something that I didn't want to mislead you on. The effort
10 it took ComEd to go from the three C's to 3 for the aspects
11 of the PRA that were important for the diesel generator AOT
12 was a major PRA update.
13 MR. BONACA: Okay.
14 MR. FLEMING: It wasn't just going in and doing a
15 few things.
16 In fact, that's what I wanted to -- let me see if
17 I can get through this key slide, because that's really the
18 one I was trying to get to.
19 In the way in which this particular certification
20 was used in this particular application, the grades themselves
21 were not used directly, and what I mean by that is that ComEd
22 didn't come in and say, hey, we got grade level 3's or, you
23 know, we got grade level 3's subject to these conditions and,
24 therefore, you know, we're a grade level 3.
25 The grades were in the process and they're an

1 important part of the process to try to ensure consistency,
2 but you know, the way the process was used is that they found
3 specific technical issues that stood in the way of getting a
4 grade level 3, and they figured out a resolution strategy to
5 get rid of those, most of which involved updates to the PRA.
6 So, there was a substantial improvement in the
7 quality of the PRA driven by the need to get approval for a
8 particular application.
9 The second thing that ComEd does is that all the
10 issues identified -- A, B, C, and D -- the S's are only
11 retained to not lose things that were successful -- are put
12 into an action tracking system, and it's ComEd's commitment
13 to address all these issues, you know, in some priority, but
14 they're going to try to roll in the schedule for addressing
15 the issues in areas that are significant for the given
16 applications, because they don't have unlimited resources to
17 do this.
18 And the final point I wanted to make here is that,
19 you know, the submittal was made in January 2000 for the
20 14-day AOT for four reactor units at two stations.
21 The safety evaluation report was granted in
22 September of this year, and in that process, NRC was given
23 sufficient information to review this submittal and address
24 quality concerns by information that was presented in the
25 licensing submittal itself, which included summary information

1 of the PRA.

2 An RAI process extracted the A and B issues and what
3 ComEd was doing about them, and that happened about a month
4 before the SER was issued, and the process was successful.

5 DR. APOSTOLAKIS: Is it possible for me to get
6 copies of the submittal and the SER? I really would like to
7 read them. Are these public documents? I would like to have
8 those. I would appreciate that.

9 Karl, the point is -- I mean you are arguing very
10 forcefully about how good this was. I'm with on that. I
11 agree with you. I think what you're presenting is very good.

12 The problem I'm having is -- and maybe it's a
13 misunderstanding on my part -- is the lower grades. I'm under
14 the impression that both the ASME standard and the NEI peer
15 review process allow a licensee to petition for something by
16 using only limited parts of PRA, without having a level 3 PRA
17 somewhere else, just to support that application and then
18 demanding that the NRC staff not look at other things, because
19 you know, some guide says there is a blank there. That's my
20 problem.

21 MR. BRADLEY: It's not the purview of the licensees
22 to demand anything of the NRC staff.

23 DR. APOSTOLAKIS: I'm sorry?

24 MR. BRADLEY: The NRC staff can certainly look at
25 any aspect they want in reviewing any application.

1 DR. APOSTOLAKIS: Yeah.

2 MR. BRADLEY: We would never demand that they not

3 look at --

4 DR. APOSTOLAKIS: If they have blessed something,

5 you know, either the ASME standard or this, then you can come

6 back and argue very forcefully that, gee, you know, you guys

7 are going beyond the rules of the game.

8 Why do we need category 1 in the ASME? Why do we

9 need category 1 here? And 2. Why don't we all agree that 3

10 makes sense?

11 Let's do it and use pieces of it as appropriate in

12 applications, which is what you're doing now with the

13 extension of the AOTs for diesels.

14 I think this is great. You told them what is

15 required to come up to standards of level 3 or grade 3, they

16 did it, now they're going to use it in a number of

17 applications.

18 That's beautiful.

19 MR. FLEMING: Well, let me give you an example. In

20 the particular example that I gave you here, what ComEd needed

21 to do is to identify the issues that stood in the way for

22 grade level 3 for those portions of the PRA that were

23 important to the diesel generator AOT submittal, and that

24 turns out to be a rather narrow range of sequences that

25 involve extended maintenance on the diesel generator that

1 don't involve issues of LOCA and ECCS and switch over to
2 recirculation and things like that.
3 DR. APOSTOLAKIS: So, they went to level 4 for
4 those?
5 MR. FLEMING: No. What I'm trying to say is that
6 they only had to make the case that the A and B issues that
7 had been identified had been resolved to the extent needed for
8 that application.
9 Now, the next application, there's another set that
10 are going to become important.
11 I think eventually -- I think that eventually we'll
12 get there, George, but --
13 DR. APOSTOLAKIS: That's a good point that you're
14 making.
15 MR. FLEMING: I think eventually we'll get there,
16 but I think one of the reasons why the industry wanted to do
17 this certification process is that, you know, if I start with
18 South Texas -- the South Texas experience, South Texas had
19 gone down a pathway, they had invested a lot in their PRA,
20 they paid the NRC for a detailed nuts-and-bolts review, much
21 more than the IPE submittal, and they went down the particular
22 path that was successful for them, and they're industry
23 leaders in that process.
24 One of the things that the industry wanted to do in
25 the certification process is to say let's see what we've got

1 now, let's benchmark what's out there right now and clarify
2 what current applications the utility could do now and
3 delineate which ones he has to defer until he invests the
4 resources necessary to bring the PRA up, as opposed to going
5 to a situation where the industry has to go off and spend
6 millions and millions of dollars to get everything up to grade
7 level 3 and now start applications.
8 DR. APOSTOLAKIS: I think that's a very reasonable
9 approach.
10 MR. FLEMING: So, it's a question of allocating
11 resources.
12 DR. APOSTOLAKIS: What you just said I cannot find
13 written anywhere, and I agree with what you said. I think
14 that, if I look at this table you just had there, you know,
15 with the ABC's and so on --
16 MR. FLEMING: Yeah.
17 DR. APOSTOLAKIS: Would you put it back on?
18 MR. FLEMING: Sure.
19 By the way, I wasn't originally planning on even
20 presenting this.
21 DR. APOSTOLAKIS: If everyone wants to do this, it
22 seems to me that's great, and then individual pieces, you
23 know, for particular applications, can afford to wait until
24 they fix the A's and B's. That's good, but that's not what's
25 in the document.

1 So, let's go on.

2 MR. FLEMING: I think part of that is that the

3 document doesn't really describe the application process.

4 DR. APOSTOLAKIS: Can you accelerate your -- be more

5 efficient?

6 MR. FLEMING: I'm just going to come to the

7 conclusion right here.

8 MR. BRADLEY: Coming from you, that's an interesting

9 request.

10 MR. FLEMING: I just wanted to summarize.

11 From this particular example, I just wanted to, you

12 know, get across a few points, that for those of us who

13 participate both on the reviewing side and the receiving

14 review comment side, the most important results of this peer

15 review process is, first of all, the delineation of specific

16 strengths and weaknesses of existing PRAs, and a clear road

17 map that results from that on what exactly does the PRA team

18 have to do to bring his particular PRA up to the level needed

19 for a given application.

20 Over time, as the certification process continues,

21 because of the participation of owners group utility

22 representatives from different plants and the information that

23 they carry back to their PRA programs, this will eventually

24 -- and it already has increased the level of consistency

25 across the PRAs, and I think where we were a few years ago --

1 or at the IPE stage, we had -- most of the variabilities in
2 PRA results were driven by assumptions, judgements, scope, and
3 things that had nothing to do with the plant.
4 I think that we're going down the right path towards
5 getting more consistent application, and the main thing that's
6 contributing to that is the make-up of the teams from the
7 owners group plant PRAs.
8 The grades were good in the sense that they provided
9 an element of consistency from certification to certification.
10 I don't want to discount that, but we're not using the grades
11 in the sense of trying to abuse them by saying, hey, we got
12 a grade level 3, leave us alone, don't bother reviewing our
13 PRA. That's not what we're saying.
14 We're saying we went through the process, we
15 identified the strengths and weaknesses, here's what they
16 were, tell the world what they were and what you did about
17 them, and I think that's the most valuable part of the whole
18 process.
19 So, that's the summary of my presentation.
20 MR. BONACA: Do you have any idea when this
21 Braidwood PRA will be a 3?
22 MR. FLEMING: What happened was that, in the Byron
23 -- the Byron PRA was reviewed approximately a year later, and
24 all of these C's but one were eliminated, and we're in the
25 process right now of trying to figure out what it takes to get

1 that up there.

2 So, I think the Byron and Braidwood PRAs are at

3 grade level 3 right now.

4 MR. BONACA: Okay. Thank you.

5 MR. FLEMING: Or if they're not, there may be one

6 or two specific issues that need to be resolved.

7 This was a year ago, and today, we're much further

8 than that, and that's another key point, is that the

9 certification process by itself does not produce quality, the

10 standard by itself doesn't produce quality, but what does lead

11 to quality is exercising the PRA in actual applications,

12 trying to make decisions from the PRA, and as a technical

13 analyst, we ask ourselves the question, how does the technical

14 conclusion derive from the analysis that I did, does it

15 logically flow to be able to support a decision, and it's

16 through exercising the PRA in specific decisions that lead to

17 quality.

18 DR. LEITCH: You mentioned earlier that, within the

19 next year, some 78 or 79 ISI applications might be received.

20 It seems to me, just on a -- thinking about it for a few

21 minutes, that perhaps all of those PRA elements would be in

22 some way tied up with the ISI program.

23 Might I then imply that, by that time, those 78

24 units would all have grade 3 PRAs, or am I getting something

25 mixed up there?

1 MR. BRADLEY: I don't think ISI necessarily would
2 exercise all those elements.
3 As risk-informed applications go, it has a fairly
4 limited scope of PRA elements.
5 DR. LEITCH: Which ones would you think would be
6 involved?
7 MR. BRADLEY: You're getting a little bit beyond my
8 expertise here.
9 DR. LEITCH: Okay.
10 MR. FLEMING: I think they are involved, but I think
11 one of the things that reduces the -- I don't know -- the
12 anxiety, if you will, about the PRA quality issue and the
13 risk-informed ISI process is that the individual decisions are
14 done on sort of a weld-by-weld basis.
15 There may be thousands of welds that you're
16 processing this evaluation, and when you start looking in
17 detail about how much the risk associated with a pipe rupture
18 at a weld is going to change because I have it in or outside
19 the inspection program, you come to get an appreciation that
20 the changes in risk that are at stake here are very, very --
21 they tend to be very, very small changes, because whether you
22 have something in or outside the inspection program doesn't
23 mean that the probability of failure goes from high to zero.
24 There's a very indirect effect of doing an
25 inspection and whether the pipe's going to rupture in the

1 first place, because you can't inspect for all the damage
2 mechanisms that could occur in the pipe, for example, and the
3 localized effects of one weld failing, either as an initiating
4 event or a consequence of initiating event -- you tend to come
5 up with very, very small numbers.
6 I don't know if you've looked at the risk-informed
7 ISI thing, but the delta risks that we're calculating are
8 very, very small, which gives us -- you know, we're so far
9 away from the decision criteria that, you know, we don't have
10 a lot of anxiety, but if you do a risk-informed tech spec, you
11 take the diesel out for 14 days, you can see some very, very
12 real potential effects on the PRA.
13 So, now, we get much more anxious about how well
14 we're calculating diesel general failure rates and common
15 cause failures and these time-dependent issues that were
16 brought up.
17 There can be big swings in the results.
18 DR. LEITCH: Let me just ask my question another
19 way, then.
20 Regardless of what the grades are, then is it
21 reasonable to conclude that these 78 or 79 units would have
22 this peer review process completed in a year, when they submit
23 these? I mean are we that far along?
24 MR. BRADLEY: The 78 units is over the next two
25 years, and given the schedule we have for peer review, I think

1 it is reasonable to conclude that they will have been through
2 that at that time.
3 It's possible that some of the plants that submit
4 will not have completed their peer reviews yet, in which case
5 they can -- there are other ways to get -- you know, NRC is
6 reviewing these applications, and there are other ways to
7 identify the PRA information if you don't have the peer review
8 results.
9 I'm sure there are probably a handful of sites that
10 will be ahead of that curve.
11 DR. SIEBER: It would seem to me that PRAs don't
12 model welds.
13 What's important is an importance measure for the
14 system or some portion of the system that would reflect a
15 chance of rupture, which you could do with a level 2 PRA.
16 MR. FLEMING: Right.
17 DR. SIEBER: Okay. So, the demand on the PRA
18 quality and content is not as high as it would be for other
19 kinds of requests.
20 MR. FLEMING: Having been involved to some extent
21 in the risk-informed ISI arena, in the risk-informed
22 application, one of the steps in the process is to -- having
23 recognized that you don't have the welds in the PRA, you don't
24 have the identity of the welds in the PRA, is to exercise the
25 PRA models that you do have so that you can simulate what the

1 effects of a postulated weld failure would be.

2 So, you end up getting to the end point, and

3 eventually, what you end up doing is developing the capability

4 to do risk significance on welds.

5 DR. SIEBER: Right.

6 DR. POWERS: I'm going to have to cut this

7 interesting discussion off. I thank you very much. Thank you

8 for the view-graphs, because I think they do merit study

9 beyond the lecture.

10 MR. BRADLEY: I'd appreciate it if you would look

11 at those, because we put a lot of effort into putting those

12 together, and we didn't get through all of them today.

13 DR. POWERS: We'll continue with the Professor

14 Apostolakis show into the staff views on ASME standard for PRA

15 for nuclear power plant applications.

16 DR. APOSTOLAKIS: Okay.

17 We have reviewed the ASME standard. What we have

18 not had the chance to do is to review the staff's comments on

19 the standard.

20 So, today, Ms. Drouin and Dr. Parry are here to

21 enlighten us on that.

22 Mary?

23 DR. DROUIN: Okay.

24 Mary Drouin from the Office of Research, and with

25 me is Gareth Parry from the Office of Reactor Regulation.

1 We're going to go through today to talk about the
2 recent activities that have happened since the issuance of
3 Revision 12 of the ASME PRA standard.
4 Back in June, on the 14th, ASME issued what they
5 called Rev. 12 of the standard for probabilistic risk
6 assessment for nuclear power plant applications. This was the
7 second time for public review and comment.
8 The NRC spent quite a bit of time during the public
9 review and comment and went through Rev. 12 in quite detail,
10 and we provided substantial comments that were a combined
11 effort between the two offices, and we provided those in a
12 letter to ASME on August the 14th.
13 In doing our review of the ASME standard, there was
14 SECY-162, which provided a lot of the guidance that we used
15 in coming up with our comments, using Attachment 1, and we
16 also went back and looked at our comments that we had made on
17 Rev. 10 to see if we still had some of those concerns, if they
18 were still valid, and looked at that in terms of Rev. 12.
19 In our letter to ASME that was submitted on August
20 the 14th -- and these four bullets are lifted verbatim from
21 the letter. I did not try and paraphrase them or anything.
22 There were four points that the staff concluded:
23 One, that Rev. 12 was not a standard that addresses
24 PRA quality. It's difficult to use in determining where there
25 are weaknesses and strengths in the PRA results and,

1 therefore, will have limited use in the decision-making
2 process.
3 It only provides limited assistance to the staff in
4 performing a more focused review of the licensee PRA
5 submittals, and the last conclusion, it provides minimal
6 assistance in making more efficient use of NRC resources, and
7 those were the four conclusions, even though there was backed
8 up with the letter, I think, about 70 pages of comments of why
9 the staff came to those conclusions.
10 What I am going to do at this point -- because we
11 don't have time to go through all 70 pages of comments but try
12 and give you a general feeling at a high level from each of
13 the chapters where our major concerns and comments were.
14 Starting with Chapter 1, the biggest thing that you
15 see in Rev. 12, in Chapter 1, was the definition of the
16 categories, and our main concerns there is that, when you look
17 at the single categories and you look at applications, there's
18 no single application that fits under each category.
19 So, from that aspect, we felt that the categories
20 were not very useful or very helpful, and the categories also
21 were being defined more from an application process, and since
22 you don't have a single application that fits under any
23 category, we felt that was the wrong way to approach defining
24 the categories.
25 When you went to Chapter 2 and looked at the term

1 --

2 DR. SHACK: Presumably, you would have the same

3 objection to the grades and the peer review process.

4 DR. DROUIN: In terms of defining those, yes.

5 DR. SHACK: Yes.

6 DR. DROUIN: Yes.

7 DR. SHACK: And I think everybody sort of agrees you

8 probably can't do that, that we really, really shouldn't be

9 focusing on -- you know, that's somebody's dream of how it can

10 be done.

11 I mean they can propose, but you dispose.

12 DR. DROUIN: Yes.

13 [Laughter.]

14 DR. DROUIN: That's one way of saying it, yes.

15 Jump in any time.

16 [Laughter.]

17 DR. DROUIN: In Chapter 2, the definitions, when we

18 looked at these, I think the words here really captured our

19 feelings that many were inaccurate, many were not written for

20 the context in which they were used, and many of them just

21 simply unnecessary, we didn't see why there was a definition

22 there proposed.

23 Maybe there were already well-known definitions for

24 these and it wasn't necessary to come up with one.

25 Chapter 3, the risk assessment application process,

1 we had several concerns in this chapter, but the biggest ones
2 is the way it was written is that, one, it doesn't provide any
3 requirements in there, and then, also, because of the way it
4 was written, it sort of exclude any minimum requirements, so
5 that when you get to Chapter 4, which was the technical
6 content, Chapter 3 almost came in and said you don't have to
7 meet anything in Chapter 4, because it always allowed you to
8 do supplementary analysis that were equally acceptable. So,
9 in essence, you ended up without a standard because of the way
10 Chapter 3 was phrased.
11 MR. PARRY: Also, I think, in that chapter, there
12 is somewhat of -- the logic isn't quite right in the sense
13 that either you meet the standard or you don't meet the
14 standard, but you present reasons to the decision-making panel
15 why you didn't, why that doesn't matter, and I think, instead,
16 the documentation seems to suggest you do something else and
17 you get around the standard and say you've met it.
18 So, it was a little -- the logic was a little
19 strange.
20 DR. POWERS: The committee certainly commented on
21 precisely that unusual feature of the standard. You cannot
22 get an N-stamp, but you do get an N-stamp if you do something
23 that's undescribed.
24 DR. DROUIN: Okay.
25 Section 4, which some might say is the heart of the

1 standard, because it gets into the technical content, and in
2 our 70 pages of comments, probably at least three-fourths of
3 our comments were on this particular chapter, and in
4 summation, where we had problems was a lack of completeness,
5 in many places just a lack of accuracy.
6 We felt that it was inaccurate in terms of some of
7 the technical requirements.
8 The logic, the organization, and the structure, the
9 supporting requirements against the high-level requirements,
10 we saw lots of problems in those area, and this was probably
11 the main one where it led back to our conclusions that we had
12 in our cover letter, were the problems associated with Chapter
13 4.
14 DR. APOSTOLAKIS: Now, the long table you have in
15 your comments on data analysis, comparing Rev. 10 to Rev. 12,
16 is under section 4, right?
17 DR. DROUIN: Is under section 4, lack of
18 completeness.
19 DR. APOSTOLAKIS: That was really a very good table.
20 DR. DROUIN: Thank you.
21 DR. APOSTOLAKIS: And in light of what Mr. Lochbaum
22 said this morning, it acquires even greater significance,
23 because I notice there was an effort in Rev. 12 to get away
24 as much as possible from using plant-specific data, and you
25 point that out in several places --

1 DR. SEALE: Yes.

2 DR. APOSTOLAKIS: -- and you know, that's the
3 complaint from UCS, that the numbers that are being used for
4 plants are generic, non-conservative, and so on.

5 DR. DROUIN: I think in our --

6 DR. APOSTOLAKIS: But that was really a good table.

7 DR. DROUIN: In our Executive Summary, we gave, I
8 thought, two good examples of things that were in Rev. 10 that
9 were not in Rev. 12 that got into that -- appropriate
10 plant-specific estimate of equipment unreliability shall be
11 developed.

12 DR. APOSTOLAKIS: Yeah, yeah.

13 DR. DROUIN: That was missing in Rev. 12.

14 DR. APOSTOLAKIS: There's a broader issue here,
15 though, and I mean I realized it when Karl Fleming was making
16 his presentation.

17 A standard is not a procedures guide.

18 DR. DROUIN: We agree.

19 DR. APOSTOLAKIS: So, a standard cannot tell you
20 which method to use, I suppose.

21 DR. DROUIN: Right. We agree with that.

22 DR. APOSTOLAKIS: So, your first statement that this
23 standard does not address PRA quality -- you didn't really
24 mean that it had to tell you had to do certain things.

25 DR. DROUIN: No. It was getting into these problems

1 here, because of these problems.

2 DR. APOSTOLAKIS: But how to do it becomes a factor

3 -- is Fleming still here? -- becomes a factor when, for

4 example, in their peer review process, the peer reviewers say

5 this is an A or B or C.

6 In other words, you're relying now on the peer

7 reviewers to know the methods and see whether the appropriate

8 method was used for a particular requirement.

9 Is that correct for both ASME and the peer review

10 process?

11 DR. DROUIN: Yes.

12 DR. APOSTOLAKIS: And everyone is happy with that.

13 DR. DROUIN: Yes.

14 MR. PARRY: That gets a comment on Chapter 6 that

15 you'll see in a minute.

16 DR. APOSTOLAKIS: Okay.

17 DR. DROUIN: I mean, from the very beginning, ASME,

18 with NRC, support that the peer review was an essential

19 ingredient of the standard, because we're never going to be

20 able to get prescriptive in the standard.

21 DR. APOSTOLAKIS: What was an essential ingredient?

22 DR. DROUIN: A peer review. That's why a peer

23 review was part of the standard.

24 DR. APOSTOLAKIS: There's something that bothers me

25 about the peer review. Is this an appropriate time to raise

1 it?

2 DR. DROUIN: Well, I'm going to get to it in two

3 more bullets.

4 We didn't have a whole lot to say on Chapter 5. We

5 felt that that was a strength of the standard.

6 DR. APOSTOLAKIS: You didn't have a whole lot bad

7 to say.

8 DR. DROUIN: That's right. The comments we provided

9 on Chapter 5 were more editorial, but we felt this was one

10 strength in the standard.

11 In Chapter 6, we had several comments. The most

12 significant was the one I put here, where we felt that the

13 focus was not on the need for reviewers to make value

14 judgements on the appropriateness of the assumptions and

15 approximations and an assessment of the impact of their

16 results.

17 This was -- should be an essential part of the peer

18 review, and we didn't see that coming out when you read

19 Chapter 6 of the standard.

20 Do you want to elaborate on that, Gareth?

21 MR. PARRY: Yeah.

22 Really, if you read Chapter 6, it almost sounds like

23 it's a QA check of the calculations, rather than an assessment

24 of how well the assumptions have been justified and how well

25 the thing has been modeled, basically. It had the wrong

1 focus, I think.

2 DR. APOSTOLAKIS: The thing that struck me as odd
3 in the peer review process, certification process, was that
4 the criteria for selecting the peers were formal.

5 In other words, does a guy have a Bachelor's degree
6 or doesn't, and if he doesn't, does he have so many years of
7 experience.

8 DR. DROUIN: That's not in the ASME. That's in the
9 NEI 02 document.

10 DR. APOSTOLAKIS: What are the criteria for choosing
11 the peers here? Is it experience again?

12 DR. DROUIN: It's experience, and in Rev. 10, it
13 read more like the certification, and we were -- ASME was
14 heavily criticized for that.

15 So, we tried to -- now, I'm speaking more as one of
16 the ASME members -- to approach it differently, and it got
17 into, you know, of course, independence, which we agreed with,
18 but we tried to move away from saying number of years, because
19 a lot of people can have a long number of years, but it
20 doesn't necessarily make them an expert.

21 So, it read more, be knowledgeable, the
22 requirements, have demonstrated experience, have collective
23 knowledge of the plant design.

24 That was at the general requirements, and then it
25 went on to be more specific about what it meant by that and

1 not come in and say, you know, you have to have five years.
2 You could have somebody who could have two years who could be
3 an outstanding person.
4 So, it tried to get more into explaining what we
5 meant by the word "expertise."
6 DR. APOSTOLAKIS: Okay.
7 DR. DROUIN: Whether it accomplished it well enough
8 could be argued.
9 Okay.
10 I'm sure, as you're aware, the NRC letter came out,
11 a lot of other public comments, but the NRC was probably --
12 their letter was probably the catalyst for some very recent
13 activities, and that's what I'm going to speak to.
14 ASME did appoint this task group to look at Rev. 12,
15 to provide advice back to ASME, and participating in this
16 effort, the staff did come in and propose a set of principles
17 and objectives of the standard, and these were through
18 different phone calls, came to a consensus on these principles
19 and objectives between NRC and industry, and this is what was
20 used by the ASME task group.
21 This task group then met on September the 19th and
22 20th, and immediately thereafter, this task group did brief
23 the NRC peer -- the NRC PRA steering committee and NEI's
24 risk-informed regulation working group and ASME on September
25 the 21st.

1 So, these next slides -- this task group did issue
2 a report on their finding.
3 I've tried not to paraphrase any of it but lift the
4 words directly from the report.
5 I wasn't going to go over these, but I did put them
6 in the hand-out.
7 These were -- there's two pages of them, and that's
8 pretty clear, actually.
9 I'm impressed.
10 But they were high-level objectives and principles,
11 starting off -- if we just look at the first one --
12 DR. WALLIS: Are these written after the work was
13 done or before?
14 DR. DROUIN: This was written before the task group
15 met.
16 DR. WALLIS: So, they should have done all these
17 things.
18 I mean if they've produced a good standard, it would
19 have met all these requirements?
20 MR. PARRY: That would have been the conclusion,
21 yeah.
22 DR. WALLIS: So, these were the objectives before
23 they started out, and somehow they went astray?
24 MR. PARRY: These are the objectives before the task
25 group started.

1 DR. DROUIN: After Rev. 12.

2 DR. WALLIS: That's what surprised me, is it would
3 seem to me this would have been written right at the beginning
4 as the objectives, specifications, and standards --

5 DR. DROUIN: That probably would have helped.

6 DR. WALLIS: -- and you wouldn't have had 12 revs
7 that didn't meet the objectives.

8 MR. PARRY: I think it's taken time to develop.

9 DR. WALLIS: But isn't this the design process? I
10 mean they were just learning the design process?

11 DR. DROUIN: Fair comment.

12 DR. WALLIS: Somebody's just learning the design
13 process.

14 DR. APOSTOLAKIS: Mary, in connection with this, is
15 the basic position of the staff that the quality of the PRA
16 -- there is a minimum standard for a quality of a PRA that
17 doesn't belong to any category.

18 You start talking about categories when you talk
19 about applications, as opposed to having categories that have
20 different quality requirements for different applications, and
21 it seems to me that the staff wants to have a good baseline
22 PRA --

23 DR. DROUIN: Yes.

24 DR. APOSTOLAKIS: -- where the quality is not
25 questionable.

1 DR. DROUIN: That's correct.

2 DR. APOSTOLAKIS: And then, if you want to apply it
3 to risk-informed ISI, then you do more or less, right? You
4 take the appropriate pieces of the PRA that apply and you say,
5 for this category, this is what I need.

6 DR. DROUIN: Let's get to the word "minimum." I
7 don't know that you need to have a minimum. I think what you
8 -- I would tend to use the word "benchmark." You want to have
9 a set, whether that set is the minimum, but where do you line
10 up to the left and right in terms of your weaknesses and
11 strengths of that.

12 DR. APOSTOLAKIS: Good PRA practice, let's say.

13 DR. DROUIN: Yes.

14 DR. APOSTOLAKIS: Present good PRA practice.

15 DR. DROUIN: You know, what are your good current
16 PRA practices?

17 DR. APOSTOLAKIS: So, you're not going to tie that
18 to the application.

19 DR. DROUIN: That's right.

20 DR. APOSTOLAKIS: And that's what the ASME standard
21 does right now.

22 It says, for different categories, the quality can
23 be different.

24 DR. DROUIN: Did Rev. 12 do that?

25 DR. APOSTOLAKIS: I thought so. For category 1,

1 here are the requirements; for category 2, here are the
2 requirements, different requirements.
3 DR. DROUIN: I think it attempted to do it. I don't
4 think it was successful.
5 DR. APOSTOLAKIS: No, I'm talking about the
6 approach, and this was also different from what Mr. Fleming
7 presented.
8 What he said was that everybody's striving to go to
9 grade 3, but then, for different applications, maybe, you
10 know, if you have a comment A that is irrelevant to this
11 application, you don't take care of it for this application,
12 but you are trying to get there.
13 I think this is an important point, because it's
14 really at the root of the disagreement, I think. It's one
15 thing to try to define quality according to application and
16 quite another to have a PRA of certain quality and then,
17 depending on the application, I may do more or less or use
18 pieces of the PRA.
19 DR. DROUIN: Okay. I'd like to get to that. There
20 was a finding on that by the task group, and I'm not trying
21 to put you off, but I'd like to answer it when we get to that
22 point.
23 DR. APOSTOLAKIS: One last point.
24 On 3, to facilitate the use of the standard for a
25 wide range of applications, categories can be defined, it

1 seems to me that, instead of trying to define categories, if
2 you give a set of examples, you avoid a lot of the debate
3 you're having right now.
4 DR. DROUIN: I think that's the same point.
5 DR. APOSTOLAKIS: Okay.
6 DR. DROUIN: I'm going to skip the next slide, which
7 is just the rest of the principles and objectives, quickly
8 show you who was on the task group.
9 DR. APOSTOLAKIS: That's interesting that Mr.
10 Fleming is not there.
11 DR. DROUIN: I cannot say why who was on this side.
12 Industry proposed their people, NRC proposed their people.
13 MR. PARRY: I think Mr. Fleming was not available
14 that week.
15 DR. DROUIN: I don't know. This is who industry
16 proposed.
17 DR. APOSTOLAKIS: Who's the chairman of this group?
18 DR. DROUIN: There was not a chairman. There was
19 what we call a facilitator.
20 DR. APOSTOLAKIS: Who is that?
21 DR. DROUIN: Syd Bernson was the facilitator.
22 DR. APOSTOLAKIS: Okay.
23 DR. DROUIN: In the task report that was issued by
24 the task group -- and again, I lifted these words verbatim
25 from the report -- this is what was stated. Let me rephrase

1 that a little bit.

2 This is what was given to the task group by ASME as
3 the charge for what the task group was to look at, and of
4 course, they're restated in the report as what the charge was,
5 and the task group was asked to evaluate the principles and
6 objectives that we were given and provide conclusions and
7 recommendations on the following.

8 The first one was, you know, is it possible and/or
9 appropriate for the standard to meet each objective, to what
10 extent does draft 12 of the standard meet each objective,
11 identify the critical technical issues associated with as many
12 technical elements as possible, and propose resolution for the
13 issues identified in 3 above and provide examples of changes
14 that could be made affecting the structure and organization
15 of the technical elements.

16 So, those were the four specific things that the
17 task group was directed to do during the two-day period, in
18 looking at Rev. 12.

19 When you just look at the charge there, just at a
20 very high level, again, as stated, I did not rewrite anything
21 by the task group.

22 The general conclusions they came to is that, when
23 you looked at the principles and objectives, they felt that
24 the standard was appropriate and it was possible to meet all
25 those objectives and standards.

1 DR. WALLIS: This is rather strange in light of your
2 -- your conclusions are very strong about what the standard
3 doesn't do, and yet, you end up here saying that they can now
4 be modified to essentially meet all the things you didn't meet
5 before.
6 It looked to me as if it would need drastic surgery,
7 not just be modified.
8 DR. DROUIN: I don't mean to -- from a personal
9 opinion, when you look at the third one, where it says it
10 should and can be modified, to imply that that's a trivial
11 process to get there.
12 DR. WALLIS: No, it's a big modification you're
13 asking for.
14 DR. DROUIN: It depends on --
15 DR. WALLIS: Your criticisms really implied that it
16 hasn't taken the main thrust, the main thrust was wrong, not
17 the details.
18 Modification, to me, means details, but you're
19 essentially attacking the main thrust of the standard in your
20 critique.
21 That would seem to me that they have to really
22 revise their approach, not just modify it.
23 DR. DROUIN: I don't think the approach was revised,
24 but the --
25 MR. PARRY: I think it really was the structure,

1 certainly of Chapter 4. It's not logically structured, and
2 I think what we felt was that the lower-level requirements
3 were addressing the issues we'd like to address in a standard.
4 It's just that they were not in a format that would make the
5 standard itself a quality document and that could be easily
6 used.
7 So, you could call that major surgery. It's sort
8 of shifting things around.
9 DR. WALLIS: So, it's a reorganization of the
10 material?
11 MR. PARRY: And some rewriting of the objectives and
12 high-level requirements.
13 DR. DROUIN: The next slides get into the details
14 of it, but I agree, it wasn't a trivial thing to do.
15 In going through the task report, I will say I did
16 take a little bit of literary license, because I wanted to
17 match up the recommendation to each of the observations.
18 When you read the task report, I think it came out
19 with 12 detailed observations, and then you went to another
20 chapter, and for each of the observations, there was a
21 recommendation.
22 So, for the sake of -- to try to put it on as few
23 slides as possible, in many cases the recommendation just
24 rewords the observation, so I didn't exactly quote on the
25 recommendation always.

1 But when you go to the detailed observations, the
2 current objective statements for the technical elements do not
3 always provide a clear description of the overall objective
4 for each element.
5 When you looked at Rev. 12, what the task group was
6 getting into is that, at the beginning of each technical
7 element, there was a set of bullets that got into the
8 objective.
9 MR. PARRY: We're talking specifically about Chapter
10 4, which is the technical requirements, for all these detailed
11 observations.
12 DR. DROUIN: Thank you. Good point.
13 When you looked at these bullets that were the
14 objectives for that particular element you never could find
15 a clear statement in there of the objective that was unique
16 and specific to that element, and we thought that that was --
17 the task group felt that that was something that was important
18 and that was missing, because then to go there to the
19 high-level requirements, you didn't see the tie in the
20 relationship, and they just weren't always consistent.
21 So, the recommendation from the task group was, you
22 know, go fix it, essentially, provide these objectives, and
23 try and make them clear.
24 Then, when you went from these objective statements
25 to the next part in Chapter 4, with the high-level

1 requirements, the task group also felt they were not logically
2 related, and they should be logically related. So, of course,
3 that was the recommendation that came out.
4 When you go into the support requirements, the task
5 group felt that the supporting requirements should fully
6 implement the high-level requirements, and what they mean by
7 that is there seemed to be an interpretation by some members
8 of the task group that, when you read the high-level
9 requirement, that there were supporting requirements that were
10 missing.
11 So, you could meet the supporting requirements and
12 you didn't necessarily meet the high-level requirements, and
13 the task group felt that that should be the other way around,
14 that if you've met the supporting requirements, then you
15 should, by definition, meet the high-level requirement.
16 So, that was one recommendation that came out, and
17 also, the supporting requirements should be your minimum set.
18 The next one that came out in terms of the
19 supporting requirements was that, when you went from technical
20 element to technical element and disregarding whether the
21 logic was appropriate or the organization but just looking at
22 the supporting requirements themselves, the task group did
23 feel that it went, for the most part, to the right level of
24 detail.
25 The two exceptions that the task group came to was

1 the data section was incomplete, but the quantification
2 section tended to be too detailed.
3 So, the recommendation there -- this one went hand
4 in hand with the above bullet.
5 So, when you looked at the recommendation, it was
6 written as one across those two observations, wanting to pay
7 particular attention to data and quantification as you went
8 through and looked at the supporting requirements.
9 The next one was getting into particular issues or
10 topics that can have a major influence on your results but
11 also where there's not usually a consensus on how to approach
12 it, and the task group felt that those should, as best as
13 possible, all of them -- you should be as complete as you can
14 be, and those should be addressed in the standard. Some
15 examples there were BWR ATWS, the consequential steam
16 generator tube rupture, dual unit initiators.
17 An example of one that is in the standard would be
18 RCP seal LOCA.
19 The recommendation that came out from the task group
20 is that, in addressing it, we did not feel that you needed to
21 give an accepted methodology but to come in, and it should be
22 part of the standard to require what approach you used,
23 document what assumptions were done, and what was the
24 significance of it.
25 MR. PARRY: It's not that we expect people not to

1 deal with BWR ATWS, but it was specific issues related to
2 that, to the timing issues and the interrelation of various
3 operator actions that need to be addressed.
4 DR. DROUIN: The next one got into the clarity of
5 the supporting requirements need to be improved.
6 We had quite a few recommendations, I just pulled
7 out the main ones.
8 We saw a lot of places to the extent necessary to
9 support category X application. We felt that was
10 inappropriate and should be replaced and explained what you
11 meant.
12 The word "may" we felt was inappropriate, because
13 it's totally permissive, so you don't know what they're going
14 to do, and the term "consider" also was another place that
15 brought a lot of ambiguity to the process.
16 Now, getting to the categories, getting back to your
17 comment, George -- now, in hindsight, I wish I had copied some
18 other things from the task group report, because this was an
19 area that the task group did spend a lot of time on.
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1 DR. DROUIN: Thank you. Good point.

2 When you looked at these bullets that were the
3 objectives for that particular element you never could find
4 a clear statement in there of the objective that was unique
5 and specific to that element, and we thought that that was -
6 - the task group felt that that was something that was
7 important and that was missing, because then to go there to
8 the high-level requirements, you didn't see the tie in the
9 relationship, and they just weren't always consistent.

10 So, the recommendation from the task group was,
11 you know, go fix it, essentially, provide these objectives,
12 and try and make them clear.

13 Then, when you went from these objective
14 statements to the next part in Chapter 4, with the high-
15 level requirements, the task group also felt they were not
16 logically related, and they should be logically related.
17 So, of course, that was the recommendation that came out.

18 When you go into the support requirements, the
19 task group felt that the supporting requirements should
20 fully implement the high-level requirements, and what they
21 mean by that is there seemed to be an interpretation by some
22 members of the task group that, when you read the high-
23 level requirement, that there were supporting requirements
24 that were missing.

25 So, you could meet the supporting requirements and

1 you didn't necessarily meet the high-level requirements, and
2 the task group felt that that should be the other way
3 around, that if you've met the supporting requirements, then
4 you should, by definition, meet the high-level requirement.
5 So, that was one recommendation that came out, and
6 also, the supporting requirements should be your minimum
7 set.
8 The next one that came out in terms of the
9 supporting requirements was that, when you went from
10 technical element to technical element and disregarding
11 whether the logic was appropriate or the organization but
12 just looking at the supporting requirements themselves, the
13 task group did feel that it went, for the most part, to the
14 right level of detail.
15 The two exceptions that the task group came to was
16 the data section was incomplete, but the quantification
17 section tended to be too detailed.
18 So, the recommendation there -- this one went hand
19 in hand with the above bullet.
20 So, when you looked at the recommendation, it was
21 written as one across those two observations, wanting to pay
22 particular attention to data and quantification as you went
23 through and looked at the supporting requirements.
24 The next one was getting into particular issues or
25 topics that can have a major influence on your results but

1 also where there's not usually a consensus on how to
2 approach it, and the task group felt that those should, as
3 best as possible, all of them -- you should be as complete
4 as you can be, and those should be addressed in the
5 standard. Some examples there were BWR ATWS, the
6 consequential steam generator tube rupture, dual unit
7 initiators.
8 An example of one that is in the standard would be
9 RCP seal LOCA.
10 The recommendation that came out from the task
11 group is that, in addressing it, we did not feel that you
12 needed to give an accepted methodology but to come in, and
13 it should be part of the standard to require what approach
14 you used, document what assumptions were done, and what was
15 the significance of it.
16 MR. PARRY: It's not that we expect people not to
17 deal with BWR ATWS, but it was specific issues related to
18 that, to the timing issues and the interrelation of various
19 operator actions that need to be addressed.
20 DR. DROUIN: The next one got into the clarity of
21 the supporting requirements need to be improved.
22 We had quite a few recommendations, I just pulled
23 out the main ones.
24 We saw a lot of places to the extent necessary to
25 support category X application. We felt that was

1 inappropriate and should be replaced and explained what you
2 meant.
3 The word "may" we felt was inappropriate, because
4 it's totally permissive, so you don't know what they're
5 going to do, and the term "consider" also was another place
6 that brought a lot of ambiguity to the process.
7 Now, getting to the categories, getting back to
8 your comment, George -- now, in hindsight, I wish I had
9 copied some other things from the task group report, because
10 this was an area that the task group did spend a lot of time
11 on.
12 The conclusion coming to the task group was that
13 the current definitions of the categories were not clear and
14 not adequate enough to help formulate the supporting
15 requirements, and it went further to say that the
16 specification applications, since they may span categories,
17 therefore, categories cannot be defined by applications.
18 And I think this is a very important point, is
19 that when you look at Rev. 12 and you go into Chapter 1 and
20 you look at the criteria that are used to differentiate the
21 application -- I mean the categories -- they were more
22 application-driven, but since you don't have a single
23 application that goes across a -- sorry -- since you don't
24 have an application that stays within one category, then it
25 doesn't make sense to use that as your criteria to

1 differentiate.

2 The task group then went the step further and

3 spent a lot of time and have proposed criteria to be used to

4 differentiate the categories and then have also come up with

5 a set of words to define each of the categories.

6 The three -- they came up with three criteria --

7 please help my memory here.

8 The first one got into the scope and level of

9 detail of your PRA, the second one dealt with how much

10 plant-specific information should be included in the PRA,

11 and then the third one was the level of realism you should

12 be bringing into the PRA, so that when you go from -- and

13 Rev. 12 only has three categories, doesn't have four.

14 So, as you go from category 1 to category 3,

15 you're going to -- if you look at the first category, which

16 is scope and level of detail, you're going to increase your

17 scope and level of your detail of your PRA as you go from

18 category 1 to category 3.

19 When you look at your degree of plant-specific

20 information, again as you go from category 1 to category 3,

21 you're going to increase the amount of plant-specific

22 information you bring in, and the same thing on the degree

23 of realism as you go from category 1 to category 3, you're

24 going to increase the level of realism.

25 MR. PARRY: Another way of saying "the degree of

1 realism," I think, is a reduction in the conservatism as you
2 go from one end to the other in terms of modeling.
3 DR. POWERS: When you say the scope varies as you
4 go from one category to the next, is there a category in
5 which it is not necessary to consider common cause failure
6 or not necessary to consider time-dependencies?
7 DR. DROUIN: No.
8 DR. APOSTOLAKIS: I think the issue of categories
9 really can be bypassed completely.
10 I mean if we come back to the basic idea that you
11 should include in the argument the things that matter to the
12 decision and things that don't matter can be left out, I
13 think if you provide, as the committee has recommended, a
14 number of examples where decisions were actually made and
15 elaborate on those, you know, what insights we gained, what
16 was important from the PRA, what was not, I think that
17 should be sufficient, in my view, and that way, you avoid
18 debates, again, as to whether category 2 makes sense, has it
19 been defined correctly, and so on.
20 I think if we see examples -- and maybe down the
21 line, after we have sufficient experience, we will be able
22 to define categories, but I really don't see the value of
23 trying to define categories.
24 It's really case by case. Karl gave us a few
25 examples earlier. You have a number of examples in your

1 earlier --

2 DR. DROUIN: You're not going to get any argument

3 from us on this point.

4 DR. APOSTOLAKIS: Yeah, but I mean --

5 DR. POWERS: Maybe I'll throw up an argument if

6 you're not going to get an argument from them.

7 [Laughter.]

8 DR. APOSTOLAKIS: Okay.

9 DR. POWERS: I mean it seems to me that we're

10 going to have people who would like to know what is the

11 minimum that I can do and still use my PRA for some

12 applications that look attractive to me, and rather than

13 having to plow through all these requirements and make some

14 judgement on which ones are applicable for some minimalist

15 activity, they'd like somebody to tell them.

16 DR. APOSTOLAKIS: My point is that you will have

17 to plow through. There is no way you won't. And all you're

18 doing now by trying to formalize it is create this debate.

19 DR. SHACK: I would look at the categories and the

20 grades -- I think you should divorce them completely from

21 applications, because I think that's a decision you make on

22 a case-by-case basis.

23 I think it's convenient to have categories or

24 grades as a shorthand description for how complete and how

25 much detail this particular PRA has gone into this element.

1 DR. DROUIN: And that's what task group did.

2 DR. SHACK: And I think that's a useful purpose to
3 have categories and grades, because PRAs, element by
4 element, will differ in those things. You could divorce it
5 completely from deciding what application -- trying to
6 determine a priori what application --

7 DR. APOSTOLAKIS: But that was Dana's argument.

8 DR. SHACK: Well, I don't like Dana's argument. I
9 want categories for a different reason.

10 DR. APOSTOLAKIS: Let me put it a different way.
11 I think defining categories right now is premature, and
12 we've seen the debate, we've seen the agony. Why don't we
13 look at a number of --

14 DR. SHACK: It's a useful way to describe the
15 level of detail and completeness of a PRA, at least to the
16 utility, so he knows what he needs to -- the most useful
17 thing out of all of this is to identify weak spots in
18 existing PRAs, so the guy can go off and do something about
19 it.

20 DR. APOSTOLAKIS: But if, per chance, I have four
21 or five analyses and studies like the ones that Fleming
22 presented, don't I get that feeling?

23 I mean he had nice tables, he told you that for
24 risk-informed ISI there is a comment A, but it's irrelevant
25 to this, so, you know, we're not going to take care of it.

1 If I look at a number of those --

2 DR. SHACK: It isn't up to Karl to define how good

3 it has to be for risk -- you know, he can suggest that maybe

4 this is good enough, but these people decide how good it is.

5 DR. APOSTOLAKIS: Sure.

6 DR. SHACK: And I really think you should get away

7 from using those grades as applications and think of them

8 more as --

9 DR. APOSTOLAKIS: I fully agree with that, but

10 what I'm saying is that it's a risk-benefit calculation

11 here. Attempting to define categories will create more

12 headaches than the benefit you get from them, at least right

13 now.

14 Was it option 2 where you have Appendix B with a

15 number of examples where, you know, in some cases, you

16 needed this kind of thing from the PRA. We commented on it

17 in our letter last time.

18 I thought that was great.

19 So, let's build up that information base first and

20 then worry about the categories.

21 The categories have been a problem with the ASME

22 standard; the grades have been a problem with the PRA

23 certification process.

24 The way Karl presented it, though, makes sense to

25 me.

1 DR. DROUIN: What the task group did was to define
2 the categories without any -- totally divorce it from
3 applications.
4 DR. APOSTOLAKIS: And quality. You can't define
5 that a priori.
6 DR. DROUIN: You have quality in all categories.
7 DR. APOSTOLAKIS: Yeah, right.
8 DR. DROUIN: So, that's what I'm saying. It got
9 into the scope and level of detail, the amount of plant-
10 specific information, and the amount of conservatism or
11 realism.
12 We felt that those were the three criteria that
13 you can use from a PRA perspective to define it.
14 Now, I said I wasn't going to present an argument
15 for the categories, but I will pick up on Dr. Powers'
16 argument, because I have been -- without mentioning names,
17 several utilities who have explained to me why they want at
18 least the category 1, and that is to have a minimum, because
19 when we sat down and we went through with the task group and
20 came up with -- I just gave you the criteria.
21 We actually then came up with a definition for
22 each of the categories, and we're going through the
23 elements, but our guideline that we were using for category
24 2 in determining what should be the scope and level of
25 detail, what should be the amount of plant-specific

1 information, what should be the degree of realism, it was
2 what is the current good practice.
3 So, as we went from element to element, you know,
4 as the eight people -- we all put in our views, what do we
5 think is the current good practice, and then we said, okay,
6 now, stepping aside from the current good practice for
7 category 1, what's the minimum that we think is acceptable,
8 so that if you don't meet that, you just don't have a PRA
9 that's of anything.
10 DR. APOSTOLAKIS: But the minimum for that
11 application or the minimum for a PRA?
12 DR. DROUIN: Minimum for a PRA.
13 DR. APOSTOLAKIS: PRA. Oh, then I'm with you.
14 DR. DROUIN: Minimum for a PRA.
15 DR. APOSTOLAKIS: I'm with you. And I think
16 that's where Fleming was going.
17 DR. DROUIN: And that's -- you know, if you're
18 going to argue categories, I think that is a good argument,
19 if you want to know what the minimum is.
20 DR. APOSTOLAKIS: My basic objection is I don't
21 want everybody to get the impression that, boy, I don't have
22 any PRA now and the NRC is telling me, if I do A, B, C, I
23 can have a category 1 application, and I don't think that
24 will ever work.
25 You have to have a baseline PRA, and then a piece

1 of that may be appropriate only for category 1.

2 DR. DROUIN: And that's been our criticism of Rev.

3 12 from the beginning. They've been trying to do it on an

4 application basis, which is not appropriate.

5 Okay. Moving on.

6 MR. PARRY: In terms of section 6 on the peer

7 review, the major thing, I think, was to try to, again,

8 emphasize that what the peer review team needs to do is make

9 a value judgement about essentially the quality of the

10 analysis, first of all see that it's met the requirements,

11 to see that it, indeed, does meet all the requirements of a

12 PRA, and then to provide an assessment of how well that's

13 been done, over and above that.

14 In terms of the application process, section 3,

15 what we felt about that was that, in terms of describing an

16 application process, it was too short, and really, to define

17 that in terms of a standard, I think you'd have to make it

18 much, much more detailed.

19 The alternative, I think, is to have a chapter

20 that defines how you would use this standard in a decision-

21 making process or in an application process, what role the

22 standard has in that process, and allow that process to be

23 described in another document, such as -- one of the ideas

24 that we threw out was an update of the PSA application, for

25 example.

1 We made one additional comment -- editorial
2 comment, really, is that additional references in the
3 document would be useful.
4 It currently has very few references, and again,
5 the reference, though, would not be to acceptable methods
6 but be to documents that were used to explain why the
7 requirements were necessary, because again, I want to get
8 away from defining acceptable methods in the standard.
9 Finally, the definitions -- well, we've already
10 mentioned that they're pretty poor and they need a lot of
11 work.
12 I think they haven't been given much attention.
13 Everybody's just blown over that chapter.
14 DR. DROUIN: The last part in the task report by
15 the task group was what future actions that would be
16 undertaken by the task group. Some recommendations were
17 also made in that area.
18 Most of the recommendations had to be where the
19 task group would provide support on the previous
20 recommendations. The task group undertook to write
21 objective statements for each element, modify the high-
22 level requirements, to go and identify where we thought
23 there were missing technical topics, not to then go through
24 and write the requirements for that, the project team, but
25 just to identify to the project team what the topics were

1 that were missing, define the categories.

2 They did that at the high level, and right now,

3 the task group is going through and writing for each of the

4 technical elements, and then to identify suggested

5 references.

6 The project team is also recommending that -- and

7 that all pertains to Chapter 4, and while the task group is

8 doing that, there's no reason why they shouldn't initiate

9 the review and resolution of the public comments on the

10 remaining chapters, and so, the recommendation was to move

11 forward with that.

12 The last recommendation from the task group is

13 they felt a small group should be organized to come through

14 -- and we used the word "organize and edit," but again, it's

15 not quite a simple as that probably implies, to go back and

16 fix that according to the principles and objectives.

17 There was several reasons why the task group felt

18 the small group from the task group ought to be formed, was

19 because, one, to approach it in your holistic manner so that

20 you were looking at all the elements together, so you could

21 deal with the consistency and make sure you had the right

22 organization and logic, instead of piecemealing it out.

23 When I say piecemeal, you know, have one group go

24 off and do one element and another group another element.

25 That's part of the problem, so to keep it to the small group

1 that did it all together, and because the task group had
2 undertaken to do the objective statements and modify the
3 high-level requirements, that consistency could be carried
4 on and just to re-clean up this part and then turn it back
5 over to the project team to go through the public comments
6 then and to resolve the public comments.
7 And that's -- I hope I've characterized correctly
8 what came out of the task group.
9 DR. POWERS: Maybe I missed it. Did they speak to
10 this issue of the supplemental analyses?
11 DR. DROUIN: I'm trying to remember. Indirectly.
12 MR. PARRY: I don't think specifically, but
13 certainly we did in the NRC comments, anyway. So, that's a
14 public comment that's going to have to be dealt with.
15 I guess, in a way, it is, by virtue of the fact
16 that it really is -- the supplemental analyses are really to
17 do with how you make decisions, and I think we were
18 recommending that the standard be somewhat divorced from the
19 decision-making process in this document but that Chapter 3
20 should make it clear how the standard would be used in such
21 a process.
22 DR. POWERS: Somebody put in the discussion of
23 supplemental analyses in Rev. 12 for a purpose. They didn't
24 succeed in whatever that purpose is, but I don't understand
25 what that purpose was, nor do I understand how the technical

1 group addressed that.

2 DR. DROUIN: As I said, I don't think we

3 explicitly addressed it.

4 To talk about Rev. 12, I think what happened is

5 you have to look at the history in terms of some evolution

6 between Rev. 10 and Rev. 12, and in Rev. 10, the same words

7 were in there, except there were a few others that said you

8 were then outside the scope of the standard.

9 When Rev. 12 came in, those words got dropped, but

10 they didn't get dropped with the intention of meaning that

11 you were still in the standard.

12 I wish I could remember some of the discussion,

13 but it had to do with the way ASME writes a standard.

14 So, the intent was never, I don't think, to say

15 that you were still -- that if you went off and did some

16 supplementary analysis, that you had met the requirements,

17 for example, of Chapter 4.

18 DR. LEITCH: Mary, maybe I have a semantic

19 problem, but I'm a little confused with what you're calling

20 categories and grades.

21 That is, ASME has set out to write a standard, and

22 in terms of the previous NEI discussion on 00-02, are they

23 trying to write a standard for a PRA that would be grade 1,

24 2, 3, or 4?

25 DR. DROUIN: ASME elected to adopt the word

1 "category" versus the word "grade."

2 DR. LEITCH: Okay. So, you're using those terms

3 kind of interchangeably.

4 DR. DROUIN: Yes. We just thought the word

5 carried meaning to it that was not truly should have been

6 there.

7 DR. LEITCH: Okay.

8 So, then, using the term "category," then, you're

9 aiming at category 1?

10 In other words, this is what you call the

11 benchmark, a minimum standard to be a PRA.

12 DR. DROUIN: Okay. The task group feels that

13 category 1 should be your minimum

14 DR. LEITCH: Uh-huh.

15 DR. DROUIN: I also think that was also the intent

16 in ASME.

17 DR. LEITCH: Okay.

18 DR. DROUIN: Has the NRC had an opportunity to

19 comment on a number of previous revisions, or is this the

20 first opportunity?

21 DR. DROUIN: In terms of ASME?

22 DR. LEITCH: Yeah.

23 DR. DROUIN: Yes. There has only been two that

24 have gone out publicly for review.

25 The other ones were just -- every time we make a

1 little change, as someone who's on the project team, it's
2 probably misleading to the public to say there have been 12
3 revisions.
4 There's only been, really, two revisions.
5 DR. LEITCH: Okay. Because I'd be a little
6 discouraged if I saw 71 pages of comments on the 12th
7 revision.
8 DR. DROUIN: And what happens is, you know,
9 Revision 1 of the ASME maybe only had two chapters in it.
10 DR. LEITCH: Okay.
11 DR. DROUIN: So, every time we put out a new one
12 internally to ourselves, just to keep track of where we
13 were, we kept calling those a revision when it wasn't truly
14 a revision to the whole standard.
15 So, the first revision that came out was Revision
16 10, and then, when the ASME team got together, you know, we
17 tweaked some things and we tweaked some more things, and
18 then we came out with the next revision, which we call 12.
19 That's an internal counting.
20 DR. LEITCH: Do you have any knowledge about the
21 schedule from here? When might Revision 13 hit the streets?
22 DR. DROUIN: They're looking to try and do it
23 within six months, and there has been a proposed schedule,
24 but that is still under refinement. That's why I didn't
25 want to get into details, because it's still proposed, but I

1 think that the goal they're looking to is to have it ready
2 for balloting within six months.
3 DR. LEITCH: So, our role here is just
4 information, discussion? What's the ACRS doing with this
5 presentation today?
6 DR. DROUIN: I don't know. We were asked to come
7 and present.
8 DR. LEITCH: Okay.
9 DR. APOSTOLAKIS: Are you requesting a letter?
10 DR. DROUIN: Are we requesting a letter? I don't
11 think so.
12 DR. APOSTOLAKIS: Okay.
13 Would it be beneficial to structure the peer
14 review process in the standard along the lines of Karl's
15 presentation, forgetting for a moment that there is a NEI
16 00-02, because you may disagree with what's in there, but
17 the idea of identifying elements that need to be done right
18 away or others, you know, are good to do but you can wait,
19 so that you can eventually reach category 2 -- I thought
20 that was a good idea, and maybe the peer review process in
21 the standard can follow something like that, instead of
22 saying, you know, just make sure that it's okay.
23 MR. PARRY: I think that's also true of -- if you
24 are familiar with the IAEA review guidance, they do a
25 similar thing.

1 They categorize their comments in things that you
2 need to do straight away, you can leave till later.
3 DR. APOSTOLAKIS: I think that's a good idea, and
4 I don't see why the standard cannot adopt something like
5 that, because it's also more specific that way, and the
6 comments, of course, will refer to what's in the standard,
7 not what's in the NEI document. That's why I'm saying
8 divorce the two.
9 DR. DROUIN: Yes.
10 DR. APOSTOLAKIS: But the table that Karl showed
11 was very good, because if you do all these things, then you
12 will have a category X.
13 Any other comments from the members?
14 DR. WALLIS: I'm trying to get an overview of
15 what's going on here, and maybe I don't know enough history,
16 but the value to having an ASME standard is that ASME is an
17 independent body and it gives some authority. It's not
18 being biased by NRC habits and so on, and therefore, it has
19 some sort of authority out there of representing the public
20 or some other group.
21 Now, the impression I get is that it's being
22 wagged completely by NRC.
23 So, if NRC is influencing the specifications and
24 objectives of the standard, it's no longer an ASME standard;
25 it's more a kind of NRC standard. It's like an SRP or

1 something.

2 DR. DROUIN: My question is what gave you that

3 impression?

4 DR. WALLIS: Just the way things have been

5 described and in the recent documents I've read.

6 DR. DROUIN: We were asked to give a presentation

7 on the activities.

8 I tried to, as best as possible, quote directly

9 from the task group, and the task group had four NRC people

10 on it and it had five industry people on it, and the

11 recommendations and observations that I presented here -- I

12 mean I happen to work with NRC, but these were observations

13 that unilaterally and unanimously were derived by those nine

14 people.

15 MR. PARRY: There's one thing that could be

16 confusing in terms of one of these bullets here. It says

17 the staff proposed a set of principles and objectives.

18 Okay. That was really -- to be honest, that was a

19 negotiated set of principles and objectives.

20 Somebody had to start it, and I can't remember

21 which -- whether it was the industry side or ourselves that

22 started it, but it was negotiated over.

23 DR. WALLIS: ASME could come back and say that

24 we're an independent body, we know what we're doing, why

25 should we respond to all these staff things.

1 MR. PARRY: It's not just the staff. It's also
2 industry. And you could argue, in fact, that the industry
3 had a major influence in changing from Rev. 10 to Rev. 12.
4 DR. DROUIN: But everything I've presented here is
5 the ASME task group.
6 DR. POWERS: Well, I think, in fact, Graham, that
7 what I've come to learn -- I, like you, naively assumed that
8 there was some body of people called the exalted ASME that
9 produced this boiler and pressure vessel code that was the
10 fount of all wisdom, and they were independent and
11 unassailable, and but that turns out not to be the case,
12 that in fact, any time they write these standards, they
13 solicit volunteers, and in this case, they solicited
14 volunteers from the staff and the industry to write the
15 standard, and they're the gurus.
16 So, there is no independent body out there. I
17 mean it's dependent upon these people that are experts.
18 Now, what we can say is these are experts.
19 One of the questions that comes into my mind both
20 about the ASME writing group and now this task group is
21 that, when I look at the membership of those things, I see a
22 lot of names of people that I have the impression feel like
23 they invented this technology that are not on this list, and
24 I'm wondering, is the ASME suffering from the fact that they
25 haven't thrown their net wide enough in selecting the

1 writing group to prepare this standard?

2 DR. DROUIN: I can't speak to how ASME selected

3 the people on their project team.

4 DR. POWERS: That was not an issue that the

5 technical group tried to address.

6 DR. DROUIN: That the task group?

7 DR. POWERS: Right.

8 DR. DROUIN: We addressed the four things that we

9 were directed to address by ASME and no more and no less

10 than that.

11 MR. PARRY: But you will notice that what the task

12 group recommended, though, was that it be a small group, not

13 a larger group, that pulled together Chapter 4, and I think

14 that's a logistical thing, that the way it's been done, as

15 Mary described, is that, you know, one group would go away

16 and do one technical element and another one would go and do

17 another, and it's really hard to get coordination unless you

18 have a focused group to do it.

19 DR. WALLIS: Who is paying for the work?

20 DR. DROUIN: Everybody.

21 DR. WALLIS: Who pays for the work? These aren't

22 all volunteers that are doing all the work, or are they?

23 DR. DROUIN: Their respective organizations pay

24 for them.

25 DR. WALLIS: Oh, you mean someone comes from

1 General Electric and General Electric pays for that person's
2 time?
3 DR. DROUIN: Absolutely.
4 DR. SEALE: If someone comes from NRC, then NRC
5 pays for their time.
6 DR. APOSTOLAKIS: The ASME's expenses, though,
7 come from?
8 DR. DROUIN: ASME.
9 DR. WALLIS: ASME members are paying for this
10 work, to some extent?
11 MR. PARRY: Well, they're paying for their staff,
12 I guess.
13 DR. SEALE: Their standards effort is a self-
14 supporting activity. That's why you pay so much for them
15 when you get them.
16 DR. APOSTOLAKIS: Well, we are running out of
17 time. Is there any other thing that is relevant to the
18 particular subject here?
19 [No response.]
20 DR. APOSTOLAKIS: The industry wants to make any
21 comments?
22 DR. DROUIN: I think Karl.
23 MR. FLEMING: Karl Fleming.
24 From the point of view of representation on the
25 project team, I wanted to make three comments pertaining to

1 the NRC review of draft 12.

2 The first comment I wanted to make is that, after
3 pouring through the 70 pages of detailed comments, I
4 appreciate the effort that the staff put in to coming up
5 with a large number of constructive comments, which I, by
6 and large, agree with, and the resolution of those that will
7 be guided by this project team that Mary is talking about
8 should provide the ability for enhanced PRA standard.

9 So, at the detail level, I really don't have much
10 of an issue.

11 I do strenuously disagree with the broad
12 conclusions that the NRC reached as a result of those 70
13 pages of comments.

14 I do not think that they flow from what's in
15 there, and I think that's the reason why it appears like we
16 do have a achievable path forward to get this thing fixed in
17 a reasonable period of time.

18 A second comment I wanted to make is that, with
19 regard to the time it's taken and so forth -- and I've been
20 with Mary, working on the project team for the last couple
21 of years -- the one thing I kind of noticed, that up until
22 but not including the NRC letter, I was kind of -- it was
23 interesting for me to note that the high-level requirements
24 which I actually suggested the introduction of after Rev. 10
25 as a way to try to address an industry concern with Rev. 10

1 that it was interpreted to be too prescriptive.

2 And I don't necessarily agree that it was intended

3 to be that way, but the high-level requirements were

4 concocted or developed as a way to provide high-level

5 requirements that were unassailable, shall be done, no

6 negotiation whatsoever, and then the detailed requirements

7 could be layered in in accordance with that.

8 The high-level requirements that are in draft 12

9 were on the street 18 months ago, and when we introduced

10 these, we made it clear that it was very important that we

11 get the high-level requirements agreed upon, because

12 everything else that needs to be done to make the detailed

13 requirement support that flows from that, and I'm just, you

14 know, kind of disappointed now that, 18 months later, we're

15 still, you know, fixing the high-level requirements.

16 I'm not arguing that they don't need to be fixed,

17 but it's just a shame that we've been trying to write a

18 standard for the last 18 months on the basis of high-level

19 requirements that still need to be revised.

20 DR. DROUIN: Karl, I agree with you, but I've just

21 got to put something in here.

22 The NRC has, through the project team -- and I can

23 go pick out e-mail after e-mail where we have provided

24 comments from just the NRC the problems with the high-level

25 requirements.

1 So, to say, you know, 18 months later, that this -
2 - you know, this comment has come forward -- we've been
3 providing comments with our concerns on those over the last
4 18 months.
5 MR. FLEMING: That's interesting, because I didn't
6 appreciate that.
7 We spent an entire project team meeting last
8 summer in Palo Alto where the 18-member project team went
9 over line item by line item of those high-level
10 requirements, and I wasn't aware, personally, that there
11 were any comments on those until today.
12 DR. APOSTOLAKIS: Any other comments?
13 MR. BRADLEY: Just a quick one.
14 In the interest of clarity and since the question
15 was asked, I would like to point out -- and I'm not familiar
16 with ASME, but for ANS, NRC has provided grants to ANS to
17 support the standards development for PRA standards.
18 DR. APOSTOLAKIS: Does it take away from the
19 objectivity?
20 DR. DROUIN: No. NRC does look at any grant
21 proposal that's been submitted, and if an organization
22 doesn't request for a grant, we can't be responsible for
23 that.
24 DR. APOSTOLAKIS: By the way, the ANS standard has
25 sort of faded away?

1 DR. DROUIN: No, they're actively working.

2 DR. APOSTOLAKIS: Actively working. We were

3 supposed to review something last month. Is it tied

4 intimately to the ASME standard, so it has to wait until the

5 ASME standard is ready?

6 DR. DROUIN: I can't comment on -- I'm not the

7 lead on that.

8 DR. APOSTOLAKIS: Okay.

9 I think we're done.

10 DR. POWERS: Okay.

11 I will recess us until -- for an hour.

12 [Whereupon, at 12:40, the meeting recessed for

13 lunch, to reconvene this same day, Thursday, October 5,

14 2000, at 1:40 p.m.]

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1 AFTERNOON SESSION

2 [1:40 p.m.]

3 DR. POWERS: Let's come back into session.

4 The next topic is going to be somewhat of a switch
5 from the previous discussion of PRA to move to PTS,
6 pressurized thermal shock, and Dr. Shack will --

7 DR. SHACK: Probabilistic analysis again but of a
8 fairly exactly sort.

9 [Laughter.]

10 DR. POWERS: Well, in that case, Dr. Shack, maybe
11 you could explain to me something about the bias analysis on
12 these parameter distributions that they were calculating for
13 this piece of work.

14 DR. SHACK: Well, I would like to say we had a
15 very good, full subcommittee discussion of the PTS update
16 project, and trying to pick some pieces out of that that we
17 should bring to the full committee, we decided it was useful
18 to have something where we could walk through the overall
19 probabilistic fracture mechanics calculation, so people
20 could see how all the pieces sort of fit together, because
21 we've been analyzing it sort of piece by piece, and then we
22 did want to go through one particular aspect on the fracture
23 toughness uncertainty -- or the fracture toughness
24 distributions, where there's an interesting discussion of
25 how the uncertainties will be treated.

1 One approach has been a purely statistical one
2 that was developed at Oak Ridge, and then there's an
3 alternate approach that's being explored at the University
4 of Maryland, and I think it's worthwhile reviewing that.
5 One thing that did come up at the subcommittee
6 meeting that I think is worthwhile bringing to the full
7 committee's attention is a concern that Dr. Kress raised
8 that's sort of similar to the problem we ran into with the
9 spent fuel problem, that if a reactor vessel was going to
10 fail, we would be getting a different kind of source term
11 than the source term that we've usually been used to dealing
12 with. That is, the core melt will occur with the --
13 essentially exposed to air, rather than in water.
14 So, it will be an air environment rather than a
15 steam environment.
16 With a different source term, this raises into
17 question exactly what is the appropriate kind of LERF
18 criterion to use.
19 The LERF criterion that we're sort of comfortably
20 using and used to using from 1.174 is really based on a
21 steam-driven source term, and again, PTS would have a
22 different kind of source term, and it might well affect the
23 kind of acceptance criteria you'd want to have for a PTS
24 incident. So, that's an issue that we did bring up with the
25 staff.

1 I'm sure they haven't had a whole lot of time to
2 address it, but it is one we think needs to be addressed
3 before the PTS update can be completed, and with that, I'll
4 turn over to the staff, and I see we have all sorts of staff
5 here today.
6 We'll have Mike Mayfield, I guess, lead off.
7 MR. MAYFIELD: All right.
8 I'm Mike Mayfield from Division of Engineering
9 Technology and Research.
10 The overall PTS project involves three different
11 divisions in research, and the pieces you're going to hear
12 about today, I guess, encompass some synthesis of ideas that
13 come from the fracture mechanics world, the materials world,
14 and some of the PRA work.
15 We certainly have welcomed the committee's input
16 and have appreciated the time you've been willing to invest
17 in reviewing this project as it's gone along.
18 We hope to continue this dialogue over the course
19 of the next year or so, as we finish off the project.
20 With that, unless Ed or Mark have something, I'll
21 turn it over to Terry Dickson from Oak Ridge to talk about
22 the FAVOR code.
23 DR. KRESS: Before you get started, I would like
24 to say it's nice to hear from somebody that doesn't have an
25 accent.

1 [Laughter.]

2 MR. DICKSON: I never thought of myself as having
3 an accent until -- I worked overseas for several years, back
4 in the '80s, and I would talk to people, and they'd say
5 where are you from? I'd say Tennessee. They'd say I
6 thought something like that.

7 I sort of started almost getting self-conscious
8 about it at that time.

9 My name is Terry Dickson, and I'm going to talk
10 about the FAVOR code.

11 I'd like to acknowledge two of my colleagues, Dr.
12 Richard Bass and Dr. Paul Williams, that work with me in the
13 heavy section steel technology program. They very much
14 helped me put this presentation together.

15 The presentation is sort of broken into distinct
16 categories.

17 The objective is to describe the evolution of an
18 advanced computational tool for reactor pressure vessel
19 integrity evaluations, FAVOR, and the first part of the
20 presentation is just how FAVOR is applied in the PTS re-
21 evaluation, and the second part is just to show how the
22 evolving technology is being integrated into the FAVOR code
23 for this PTS re-evaluation.

24 The third section is just kind of about the
25 structure of the FAVOR code, and the fourth is kind of an

1 overall PRA methodology, and there's a fifth section that
2 really isn't part of this presentation.
3 This is basically the same presentation I gave in
4 September, but it's sort of been decided since then that
5 maybe we need maybe a little more work in this last area.
6 So, really, this presentation will deal with the first four
7 of these.
8 This sort of goes, I guess, right to the heart of
9 the matter.
10 Application of FAVOR to the PTS re-evaluation
11 addresses the following two questions.
12 Here's a graph that plots or demonstrates the
13 frequency of RPV failure in failures per reactor year
14 plotted as a function of effective full-power years. Also,
15 you could think of this as RTNDT, you could think of it as
16 neutron fluence; in other words, the length of the time that
17 the plant has been operating.
18 And this, I might add, is the type methodology
19 that was used in the SECY 82-465 analysis, from which the
20 current PTS screening criteria was derived.
21 So, the two questions here is, at what time in the
22 operating life of the plant does the frequency of reactor
23 pressure vessel failure exceed an acceptable value?
24 So, we see this red line increasing, the frequency
25 of vessel failure increasing as a function of time, and the

1 current value is 5 times 10 to the minus 6.

2 So, the question is, at what time in the operating

3 life of the plant does the frequency of failure exceed a

4 certain value, and then, the second question that we're

5 particularly interested in here with this re-analysis is how

6 does the integration and application of the advanced

7 technology affect the calculated result.

8 And this is just an attempt to show that, you

9 know, this second curve, this blue curve, if you went back

10 and re-did this analysis, with an improved model, which we

11 think we have, an improved model, or a plant-specific

12 mitigation action, that you would shift this curve in such a

13 way that you would be able to operate the plant an

14 additional period of time and still be in compliance with

15 some level of failure, frequency of failure.

16 So, in the context of this presentation, what

17 FAVOR does it generates this type curve, and you would run

18 FAVOR -- an execution of FAVOR would give you one point on

19 the curve, and then you would have to -- as I talk about

20 FAVOR -- I mean this is what we're doing.

21 We're plotting point on this curve to see how the

22 frequency of the failure increases as a function of the

23 time, and specifically how these improve models.

24 Now, one thing I will point out -- and I will

25 probably refer back to this slide as I go through the

1 presentation.

2 This just shows it as a line. This just shows it

3 as discrete values.

4 In reality, there will be some distribution about

5 this.

6 In other words, you can think of this as being the

7 mean value of the distribution that comes out.

8 DR. APOSTOLAKIS: Was there an uncertainty

9 analysis actually done for the red line?

10 MR. DICKSON: Yes.

11 DR. APOSTOLAKIS: At that time?

12 MR. DICKSON: Well, I may ask Professor Modarres

13 to help me out here.

14 All the uncertainty -- as I step through the

15 presentation, maybe I'll be able to address that question

16 better.

17 DR. APOSTOLAKIS: That refers to the blue line,

18 the one you're developing now.

19 I'm asking about the old analysis.

20 MR. DICKSON: The old analysis did not have an

21 uncertainty analysis.

22 DR. APOSTOLAKIS: So, the red line is -- we don't

23 know what it is.

24 MR. DICKSON: Right.

25 DR. APOSTOLAKIS: Some sort of a best estimate.

1 MR. DICKSON: Yes.

2 DR. APOSTOLAKIS: Would you define effective full-
3 power years?

4 MR. DICKSON: An effective full-power year is a
5 calendar year at which the vessel -- at which the core was
6 operative.

7 DR. KRESS: If it's only part-power, you count
8 that as a fraction of power.

9 One of the things that bothered me about this is,
10 if the 5 times 10 to the minus 6 were only 2 times 10 to the
11 minus 6, which ain't a lot difference, you drop all the way
12 down to 15 years on the red line or the blue line, too.

13 MR. DICKSON: This really isn't numbers from an
14 actual analysis. This is for illustrative purposes only.

15 DR. KRESS: Right. But that's an illustration of
16 the same point.

17 MR. DICKSON: Yes.

18 That was one of the outcomes of the IPTS analysis,
19 that the shape of these curves -- as you know, there was an
20 analysis done for each of the three domestic vendors, and
21 the shape of that curve seemed to be slightly different for
22 a Westinghouse versus a B&W versus a CE.

23 DR. POWERS: Westinghouse versus CE is a little
24 surprising, but Westinghouse versus a boiler, you wouldn't
25 be surprised about that, would you?

1 DR. KRESS: I don't think you've done it for
2 boilers, have you? It's a B&W plant.
3 DR. APOSTOLAKIS: So, if I have two years at half-
4 power, then those would count as one effective full-power
5 year?
6 MR. DICKSON: Yes.
7 Typically, I think -- I think, typically -- and
8 somebody correct me if I'm not right, that a typical
9 licensing period is for 32 effective full-power years, I
10 believe, which I think sort of equates to 40 calendar years,
11 if you figure, you know, 20-percent down time.
12 Okay.
13 So, the near-term schedule for the development of
14 the FAVOR code has been recently defined, and the current
15 schedule specifies FAVOR to be ready for the PTS re-
16 evaluation analysis March 1st of next year.
17 Between now and then, the models are being
18 finalized, and the finalized models are being implemented
19 into the FAVOR code, and scoping studies will be performed,
20 and the idea at this time is that the Oconnee plant will be
21 the vehicle for performing the scoping studies.
22 The primary reason is that the thermal hydraulics
23 folks are doing Oconnee first. So, we'll have all the input
24 data.
25 We'll have the PRA data in the form of initiating

1 frequencies.

2 We'll have the thermal hydraulics data from the

3 thermal hydraulics branch.

4 We'll have the flaw data from the appropriate

5 people.

6 So, all the data will be there to sort of start

7 shaking down the code and seeing -- kind of seeing where the

8 numbers come out.

9 So, Oconnee will be the first application of all

10 this technology.

11 Since this presentation is about the status of the

12 FAVOR code development, we sort of thought it might be

13 appropriate to sort of show a little of the historical

14 evolution of how the FAVOR code came to be.

15 By the way, for those of you that don't know,

16 FAVOR is an acronym, Fracture Analysis of Vessels Oak Ridge.

17 Development of the FAVOR code was initiated in the

18 early 1990s by combining the best attributes of the OCA and

19 the VISA code with evolving technology.

20 There was a series of codes -- OCA-1, OCA-2, OCA-

21 P -- that was developed at Oak Ridge National Laboratory in

22 the early 1980s, OCA standing for Over-Cooling Accident.

23 There was also, in parallel, an effort that was

24 initiated within the NRC and later was taken up PNNL. They

25 did a code called VISA-1, VISA-2, as I said, that was done

1 by the NRC, PNNL, in the same timeframe, and both of these
2 codes were applied during the SECY 82-465 analyses, as well
3 as the integrated pressurized thermal shock analyses.
4 So, both of these codes sort of fed into -- in
5 other words, we took the best parts of OCA, the best parts
6 of VISA, plus lessons learned from the IPTS, integrated
7 pressurized thermal shock, as well as a lot of lessons
8 learned from the Yankee Rowe experience. All of these fed
9 into the development of FAVOR.
10 The first public release of the FAVOR code was in
11 1994, followed up by an improved version, the '95 version.
12 There was a limited release in 1999, limited to this group
13 of people that have been coming to these NRC meetings,
14 primarily from the industry, as part of this PTS re-
15 evaluation. So, some of the things I will be talking about
16 were incorporated into that version, but clearly, we're --
17 the code is continuing to evolve, and as I said earlier, the
18 goal right now is to have a development version fixed by
19 March of 2001.
20 This is just sort of a transition slide to say
21 we'll now talk a little about the integration of evolving
22 technology into the FAVOR code.
23 Okay.
24 Elements of updated technology are currently being
25 integrated into the FAVOR computer code to re-examine the

1 current PTS regulations, and this is just an illustration
2 kind of all of these boxes out here on the periphery of how
3 they are feeding in -- these are areas that clearly have
4 been improved since the analyses that were done in the 1980s
5 from which the current Federal regulations for PTS were
6 derived, such as detailed neutron fluence maps, flaw
7 characterizations, embrittlement correlations, better
8 thermal hydraulics, better PRA methodologies.
9 The RVID database is the reactor vessel integrity
10 database which has been developed and is maintained by the
11 Nuclear Regulatory Commission, which basically is kind of a
12 repository of all the, I guess you would say, official
13 vessel characteristics such as chemistry. If you wanted to
14 know the chemistry of a particular weld in a particular
15 plant, you'd go to the RVID.
16 Extended fracture toughness databases, fracture
17 initiation toughness, fracture mechanics, and the FAVOR code
18 itself is one of the boxes that certainly is an improvement
19 of technology since the 1980s.
20 DR. WALLIS: Now, thermal hydraulics hasn't
21 improved yet, has it?
22 MR. DICKSON: I suppose what is intended here is -
23 - I don't know what release of RELAP was used in 1985, but
24 certainly, it's a later release of RELAP, and certainly, I'm
25 sure you're well aware of the APEX experiments and so forth,

1 that there's an attempt to validate --

2 DR. WALLIS: Which haven't been done yet.

3 MR. DICKSON: I think it's supposed to happen

4 during the fall of this year.

5 MR. BOEHNERT: They just started, Graham. They

6 just started testing.

7 MR. DICKSON: So, I guess what is meant here -- we

8 would hope that we have better thermal hydraulic analyses

9 now than 15 years ago.

10 So, in any case, all of these are going to feed in

11 -- you can think of all of these sort of being input data

12 into the process, because the FAVOR code sort of has to have

13 a software interface here with all of these elements.

14 So, they all feed into this updated technology PTS

15 assessment.

16 Hopefully, at the end of the day, we'll have a

17 technical basis for the revision of PTS regulation. There's

18 no way of knowing which way it's going to go at this time.

19 I think we started into this process thinking that the

20 potential exists for there to be a potential for relaxation

21 of the current regulations.

22 We'll talk a little bit more about that, but

23 basically, we're going to put all the stuff in, turn the

24 crank, and let the chips fall where they may.

25 Okay.

1 This is a little bit redundant.

2 This is just, in words, sort of repeating what we
3 had there in that last one. Advanced technology is
4 integrated into FAVOR to support possible revision of the
5 PTS regulation, flaw characterizations from the NRC research
6 -- we'll talk a little bit more about that in a moment --
7 detailed fluence maps, embrittlement correlations, RVID
8 database, fracture toughness models, surface-breaking and
9 embedded flaws, inclusion of through-wall weld residual
10 stresses, and a new probabilistic fracture mechanics
11 methodology.

12 As I said, that's slightly redundant, but probably
13 the reason that I'm standing here now talking about this is
14 we sort of did some analyses a couple of years ago to sort
15 of see what -- if someone was to revisit some of the IPTS
16 analysis and use some of the improved models, what the
17 impact might be, and at that time, it looked like -- as I
18 previously said, it looked like that the potential existed
19 for a relaxation of the regulations, and the singular most
20 important contributor to that was a significant improvement
21 in the flaw characterizations, okay?

22 A significant improvement since the derivations of
23 the current PTS regulations is flaw characterization,
24 because in those analyses, the SECY 82-465, as well as the
25 integrated pressurized thermal shock, they assumed that all

1 of the flaws were inner surface-breaking flaws, okay?
2 It was known that that was a conservative
3 assumption, but kind of in the absence of any other
4 knowledge, that was the assumption that was made.
5 Well, the NRC, I would say, has wisely spent their
6 research dollars since then performing non-destructive
7 examination as well as destructive examination of RPV
8 material at Pacific Northwest National Laboratory to improve
9 a technical basis for the flaw-related data used as input
10 into these probabilistic analyses, and what has come out of
11 this -- and it's a continuing, ongoing process, but what has
12 come out of this is that a significantly higher number of
13 flaws were found than were postulated in the original
14 analyses. However, all of the flaws so far that have been
15 detected are embedded, as opposed to inner surface-breaking.
16 PVRUF, for those of you that don't know, is the
17 Pressure Vessel Research User Facility, which was actually a
18 vessel that was never put into service.
19 It was brought to Oak Ridge, it was cut up, and
20 the non-destructive examination as well as the destructive
21 examination performed on it.
22 When you take those flaw densities and apply them
23 to a commercial pressurized water reactor, what you predict
24 is that you will have between three and four thousand flaws
25 in the first three-eighths thickness of the vessel.

1 So, as I say, you have a lot more flaws, but
2 they're sort of more benign, they're embedded, from a
3 fracture point of view, and we'll talk a little bit more
4 about this in a moment, but I guess the thought that I would
5 want to leave you with with this slide is that, out of all
6 of the little boxes feeding into this, this flaw
7 characterization, by far, has the highest potential for
8 impacting the answer.
9 DR. LEITCH: When you say first three-eighth-inch
10 thickness, that's from the inner wall?
11 MR. DICKSON: Yeah.
12 DR. LEITCH: Okay. Thank you. And it's not
13 three-eighths of an inch, it's three-eighths --
14 MR. DICKSON: Three-eighths of the wall thickness.
15 DR. LEITCH: Thanks.
16 DR. POWERS: When you think about fracture
17 mechanics on these vessels and flaws breaking the surface,
18 you mean the surface surface or do you mean they break below
19 the cladding?
20 MR. DICKSON: When I say inner surface breaking, I
21 mean inner surface breaking; they originate on the inner
22 clads on the wetted surface.
23 Okay.
24 In the original analysis, SECY 82-465, as well as
25 the integrated pressurized thermal shock, as well as the

1 Yankee Rowe, normally what you would do is you would take
2 the highest neutron fluence value and assume that that was
3 acting everywhere, okay, and it was known that that was
4 quite conservative, too.
5 It's like let's put all the flaws on the inner
6 surface, because we don't know anything else to do.
7 Well, there usually wasn't detailed neutron
8 fluence maps available at that time, so one of the things
9 that, as I say, lessons learned, is to come up with a
10 methodology that allows the RPV belt-line to be discretized
11 into sub-regions, each with its own distinguishing
12 embrittlement-related parameters, which -- therefore, this
13 accommodates chemistries from the RVID database and detailed
14 neutron fluence maps, because the reality is, as I'll show
15 in some slides here in a moment, this section of the vessel
16 may be considerably less embrittled than here.
17 So, to assume that it all has the same
18 embrittlement was quite conservative, and rightly so, some
19 of the industry people were saying, but in the absence of a
20 tool to incorporate this into the analysis, you know, you
21 took the most conservative route.
22 DR. WALLIS: What does this figure show? I don't
23 understand.
24 MR. DICKSON: Okay. I'm sorry. What this figure
25 is showing here -- this is attempting -- think of this as

1 the vessel rolled out, unwrapped, from zero to 360 degrees,
2 where this is the core active region.
3 Traditionally, the analyses have been -- when you
4 talk about the belt-line region, you talk about,
5 traditionally, from one foot below the core to one foot
6 above the core, and so, these green regions here are meant
7 to be welds, whereas the gray-like, whatever color this is,
8 is plate material.
9 So, what I'm saying here is that the FAVOR code
10 has a methodology that allows you to break it down like
11 this.
12 DR. WALLIS: Doesn't look like a very fine grid.
13 MR. DICKSON: Well, this is just for illustrative
14 purposes.
15 I mean you can break it down as fine as you -- the
16 code leaves that up to the user. That's the discretion of
17 the user.
18 You break it down as fine as you want to.
19 Well, that's not entirely true.
20 DR. SIEBER: But that really doesn't make any
21 difference as far as the geometry, because once a fracture
22 starts, it will start in the most vulnerable place?
23 MR. DICKSON: Not necessarily. We'll maybe get to
24 that in a moment.
25 I hate to generalize, because there's always the

1 exceptions, but more often than not, the plate material is
2 less embrittled than the weld material, okay? And even if
3 you say, okay, the plate has a flaw density of one-tenth or
4 1/50th that of the weld material, you may still have cases
5 where the less embrittled plate material drives the
6 analysis, in other words contributes more to the overall
7 risk of failing the vessel just by virtue of -- there's
8 probably, out of 100 percent of this material, probably 99
9 percent of it's plate material.
10 It has a lot less density of welds, but still it -
11 - flaws -- but at the end of the day, you have a lot more
12 flaws.
13 In the old way of doing these analyses, as I said,
14 you would take the most limiting and sort of concentrate on
15 that.
16 DR. UHRIG: This is a belt-line weld around the
17 middle of the vessel right there?
18 MR. DICKSON: Yeah, that's a circumferential weld.
19 DR. UHRIG: All right. Then the core is above the
20 center --
21 MR. DICKSON: Here's the core.
22 DR. UHRIG: Okay. I thought it was down -- about
23 split equally.
24 MR. DICKSON: Well, as I say, when we talk about
25 the belt-line region -- and maybe the next slide will help

1 here a little bit.

2 DR. UHRIG: Okay.

3 MR. DICKSON: In fact, let's just move to the next

4 slide.

5 This is actually some real data, and the NRC

6 contractor, by the way, that's doing the neutronics

7 calculations to generate the neutron fluence maps -- this

8 work is being done at Brookhaven National Laboratory, and

9 this actually is from one of those analyses where they sent

10 me the data, and this shows, again, from zero to 360

11 degrees, so if you can think back to that previous slide of

12 the unwrapped vessel, this shows the asmuthal variation of

13 the neutron fluence at particular axial locations.

14 Now, this one here is at 72 inches from above the

15 bottom of the core; in other words, kind of at mid-core. In

16 other words, this is sort of the worst location, the worst

17 axial location, and you can see that -- of course, this is

18 repeating.

19 It has a periodicity of 45 degrees. It goes down

20 to 45 degrees, and then it's a mirror image of itself the

21 next 45 degrees, and then it just repeats itself. So,

22 that's 90 degrees, and it just repeats itself three more

23 times as you come around the 365 degrees.

24 DR. WALLIS: Why does it vary so much?

25 MR. DICKSON: You'll have to talk to someone other

1 than me.

2 DR. SHACK: In the original analysis, you would

3 assume the worst fluence, the worst chemistry, the worst

4 thermal hydraulics, all at one location, and then you'd do a

5 distribution of flaws and do the fracture mechanics on that?

6 MR. DICKSON: Right.

7 DR. KRESS: Now, you have a thermal plume coming

8 down from the hot leg.

9 Where is it located with respect to those high

10 points?

11 MR. DICKSON: At the moment, we assume an axial

12 symmetric loading, okay?

13 Now, to answer your question, you know, your

14 inlets are, you know, somewhere up here, and some of the

15 APEX experiments are directed toward this issue.

16 In other words, have the plumes dissipated by the

17 time you get down to the top of the core, and certainly

18 that's been the assumption so far in most of our analyses,

19 and it's not just out of thin air.

20 I believe that Dr. Theofanis has some publications

21 that states that, for commercial, domestic PWR designs, that

22 that plume pretty much has dissipated by the time the

23 coolant gets down to the top of the core.

24 DR. KRESS: That was part of his remix.

25 MR. DICKSON: Yes.

1 We've done some work in this in the past, and I
2 think we will try to verify this one more time. It's
3 certainly our intent to -- we were involved in asking -- you
4 know, in designing where the instrumentation went on the
5 APEX experimental device for this very reason.
6 We would like to sort of verify that one more time
7 that that's the case.
8 MR. MAYFIELD: Terry, could I stop you for just a
9 second?
10 MR. DICKSON: Sure.
11 MR. MAYFIELD: This is Mike Mayfield from the
12 staff.
13 I wanted to make sure we understood the
14 distribution of flaws Terry's talking about are fabrication-
15 induced flaws rather than service-induced.
16 So, we're talking about things that are in the
17 vessel from the day it's built, as opposed to things that
18 are induced by service.
19 DR. SHACK: What's the rationale for ignoring the
20 clad completely?
21 MR. MAYFIELD: Well, we don't ignore it
22 completely.
23 DR. SHACK: I mean in the original calculation.
24 MR. MAYFIELD: Even then, it was treated as -- it
25 was taken as a conservative measure. So, it's not

1 incorporated from a fracture mechanics standpoint but from
2 the material toughness standpoint.
3 It was included in terms of the differential
4 thermal expansion you get.
5 DR. SHACK: But you put the flaws on the inner
6 surface of the clad.
7 MR. MAYFIELD: Put the flaws on the inner surface,
8 and you treated the metal like it was all faradic steel,
9 rather than have the clad layer on it, except in the stress
10 analysis, and there you picked up the differential thermal
11 expansion, and I guess also, by association, the thermal
12 analysis, because you pick up some thermal conductivity
13 issues, but it was -- I think people didn't know exactly how
14 to handle the duplex nature of the structure, so treated
15 conservatively for the analyses that were done in the early
16 '80s.
17 MR. DICKSON: Pretty much what Mike said is still
18 true today.
19 Certainly, the little stainless steel clad is
20 factored in in the calculation of the thermal response of
21 the vessel, as well as the stress, even in the K1, the
22 stress intensity factors for inner surface breaking flaws,
23 but we do not check flaws that reside entirely in the clad
24 for a cleavage fracture, because it's stainless steel, and
25 it's much more ductile than the base material.

1 So, to pretend that a cleavage fracture event
2 could initiate there is just denying reality. It just isn't
3 going to happen.
4 Thinking back to the previous slide, this shows
5 the level of the neutron fluences at one foot above the core
6 and one foot -- you can see that it's decayed practically to
7 zero by the time you get one foot above and one foot below,
8 and this just shows the neutron fluence as a function --
9 it's the axial gradient. So, at the core flats, at zero,
10 90, 180, and 270, there is the axial variation, and there it
11 is at other values.
12 So, the point that these slides are -- it's just
13 that FAVOR has the capability to handle this kind of detail
14 in your fluence map.
15 DR. SIEBER: In the righthand figure, where's the
16 top of the core?
17 MR. DICKSON: Zero is at the bottom. Zero is one
18 foot below the bottom of the core.
19 DR. SIEBER: I would have expected that embedded
20 control rods would have caused that shape, as opposed to --
21
22 MR. JONES: Excuse me. This is Bill Jones from
23 Research, NRC staff.
24 That particular reactor has a fuel management
25 scheme in the bottom of the core to hold the fluence down

1 the vessel welds.

2 So, that's why it has that maybe not

3 characteristic shape, but that's why that particular axial

4 looks that way.

5 DR. SIEBER: Is that burnable poisons?

6 MR. JONES: No, it is not. I believe it's

7 stainless steel.

8 DR. SIEBER: Oh, all right.

9 DR. POWERS: If we have high burn-up fuel and get

10 axial offset anomalies, does it distort these distributions

11 substantially?

12 MR. DICKSON: I'm sorry. I didn't catch the first

13 part of that.

14 DR. POWERS: If we use high burn-up fuel and we

15 get axial offset anomalies, does it distort these fluences

16 substantially?

17 MR. DICKSON: I'll defer to the neutron people on

18 that.

19 MR. JONES: I'm sorry, Dr. Powers. You'll need to

20 repeat that again.

21 DR. POWERS: What I'm asking is, when people use

22 very high burn-up fuels, they get a little boron absorption

23 up high in the rods, and that causes a shift in the spectrum

24 down to lower parts of the core. I'm wondering if it

25 changes the fluences to the vessel enough to make a

1 difference in your calculations.

2 MR. JONES: Well, these calculations are pretty -

3 - we tried to match -- the plants we did, we tried to match

4 the way the cores would burn.

5 For the future, what I believe ought to be done is

6 that calculations will be done matching the way the core was

7 burned, so the codes would be adequate to account for that

8 spectral shift and do an adequate job of calculating what

9 the fluence would be at the vessel wall.

10 DR. SIEBER: I take it, just as a follow-on, that

11 this is a sort of an average profile, as opposed to -- since

12 axial offset occurs, even in a moderately burned core, that

13 this is some kind of an average, as opposed to doing this in

14 slices in time during a cycle.

15 MR. JONES: It was done as slices in time, but

16 certainly it's an average between those slices, yes.

17 MR. DICKSON: If I'm not mistaken, Bill, I believe

18 these asmuthal -- I believe they were about 3 degrees -- the

19 increment, I believe, was like 3 degrees and the axial was

20 like 6 inches or something like that, in that neighborhood,

21 pretty small.

22 I can tell you this: This is quite a bookkeeping

23 exercise to keep up with this. A lot of data goes into the

24 analysis.

25 DR. KRESS: Do you digitize that before you input

1 it?

2 MR. DICKSON: Yeah.

3 Of course, you know, as we know, in reality, it's
4 a continuum, but as you often do, mathematically, you have
5 to discretize.

6 DR. SEALE: These neutron maps were generated
7 using the revised DNDFB -- what is it, 6? -- cross-sections
8 to more properly distribute the energy in the heavy steel?

9 MR. DICKSON: I'll defer to Bill on that.

10 MR. JONES: I believe it's 6, but the calculations
11 only go to the inside -- we're only using fluences at the
12 inside of the vessel wall.

13 MR. DICKSON: Right. I guess I should have said
14 that from the outset.

15 It's understood that this is the magnitude of the
16 fluences on the inside, and of course, it goes without
17 saying, this is at a particular time in the plant life,
18 remember, back to that first graph.

19 You know, we're doing an analysis to plot a point
20 as a function of EFPY. Ten years later, everything would be
21 up, you know.

22 Any questions, comments?

23 DR. SHACK: What do you then do to get the
24 distribution through the wall if you stop the fluence
25 calculation?

1 MR. DICKSON: We attenuate it, and we use an
2 exponential to K constant of .24.
3 DR. SIEBER: What's the basis of that?
4 MR. DICKSON: There's people in this room that can
5 speak to that better than I can.
6 MR. LOIS: We derived in the '80s, and it came
7 from a transport calculation for the vessel.
8 Later on, we found that the displacement measure
9 that some people used -- it gives approximately the same
10 sort of grade through the vessel.
11 But the one that is in the book, in the
12 regulations right now, in Regulatory Guide 199, is the decay
13 through the thickness of the vessel.
14 MR. DICKSON: Actually, the data that Brookhaven
15 provided actually had data through the wall, and Bill Jones
16 has actually gone through the exercise and sort of verified
17 that the .24 is still very much applicable, if anything
18 slightly conservative.
19 Is that true, Bill?
20 MR. JONES: Yeah.
21 MR. DICKSON: You found the .24 is still a valid
22 number, and when it was off, it was off on the conservative
23 side.
24 MR. JONES: That's a true statement.
25 MR. DICKSON: Okay.

1 DR. WALLIS: What are the units of this .24?

2 MR. DICKSON: Inches minus one.

3 DR. WALLIS: Inches. You're in the dark ages.

4 [Laughter.]

5 DR. WALLIS: Even at MIT in the '50s, we used

6 metric, as far as I can remember.

7 Well, go on.

8 MR. DICKSON: Well, divided by 25.4, I suppose.

9 DR. KRESS: In Tennessee, we can divide.

10 [Laughter.]

11 MR. DICKSON: Speaking of MIT, I was at a meeting

12 with Dr. Peter Griffith. The thing about units came up, and

13 he said, well, I prefer to use Christian units, and I think

14 he was talking about English units.

15 DR. APOSTOLAKIS: I believe he's retired now.

16 [Laughter.]

17 MR. DICKSON: Okay.

18 Moving along, new statistical models for enhanced

19 plane strain static initiation and arrest fracture toughness

20 databases have been implemented into the FAVOR code.

21 Okay.

22 Now, this shows K1C. This is fracture initiation

23 toughness, plotted as function of T minus RTNDT.

24 Now, the old ASME curve that's been around since

25 the early 1970s was derived from a database collected by

1 EPRI, Electric Power Research Institute, and within the last
2 year, year-and-a-half, at Oak Ridge, we went through and
3 found how much additional data had been generated since then
4 -- it's been 28 years -- and found that there have been, I
5 believe, 83 additional valid points that were valid
6 according to certain ASTM regulations, and I'm not going to
7 get bogged down in that detail.
8 So, we said, okay, we'll take the enlarged
9 database and really do a rigorous statistical analysis on
10 it.
11 Now, Dr. Kenny Bowman and Dr. Paul Williams did
12 this and came up -- they fitted this with a WIBLE
13 distribution. So, this shows your 254 points, and this
14 actually shows the WIBLE distribution that they fitted to
15 that.
16 This bottom curve shows the -- it's actually the
17 location parameter, the WIBLE location parameter, which is
18 the lowest possible predicted K1C that you would ever
19 predict, and this shows, you know, the 1/1,000th percentile
20 and the 99.999 percentile, as well as the median, did the
21 same thing for the fracture -- the crack arrest, known as
22 K1A, and these are very important inputs into fracture
23 analysis, into a probabilistic fracture analysis, how you
24 statistically represent or, if you prefer, represent the
25 uncertainty associated with the fracture data.

1 DR. POWERS: It seems to me that the 99.999
2 percent line and the .001 percent line are very dependent on
3 having selected WIBLE distribution, that if you'd selected
4 something else, they would have greater or lesser width to
5 them.
6 Now, it seems to me that the WIBLE distribution
7 has an empirical justification that applies in -- between
8 the 90th and the 10th percentile.
9 What justification is there to extrapolate it so
10 far out, 99.999 percentile?
11 MR. DICKSON: I'm not sure that I can address it.
12 Mark, would you like to speak?
13 DR. KIRK: Mark Kirk, NRC staff.
14 Maybe we can just defer that to my presentation,
15 but there are physical reasons why you would expect and can,
16 in fact, demonstrate that fracture toughness data should
17 have a WIBLE distribution.
18 What Terry is showing is a result of a purely
19 empirical analysis of the data, which happened to find that
20 a WIBLE was the best fit to the data.
21 Nevertheless, there's a good theoretical and
22 physical justification for why the WIBLE should work, which
23 I think helps to build the case that you should be using it,
24 but you're absolutely correct, any model just picked from
25 empiricism, out at the tails, you can have significant

1 effects.

2 DR. KRESS: I don't think you have intention of

3 using the 99.999 for anything except the decision-making

4 process.

5 MR. DICKSON: No.

6 DR. KRESS: It's just on there for illustration.

7 MR. DICKSON: Right. It's on there for

8 illustration.

9 But certainly, the tails of the distribution can

10 be quite important in these analyses sometimes.

11 DR. APOSTOLAKIS: I don't see the distribution,

12 but you must have done something else somewhere else,

13 because here there is K versus R minus RTNDT.

14 DR. KRESS: Is the distribution vertical?

15 DR. APOSTOLAKIS: Where is the probability?

16 MR. DICKSON: I actually have a little back-up

17 slide here.

18 I don't know if this will help.

19 This shows the distribution at any vertical slice.

20 DR. APOSTOLAKIS: Okay. So, R minus RTNDT is a

21 parameter.

22 MR. DICKSON: Yes.

23 DR. APOSTOLAKIS: And you have a distribution for

24 each value of that.

25 MR. DICKSON: Yes.

1 DR. APOSTOLAKIS: Okay. So, then you take the
2 99th percentile of each curve, and you plot it as a function
3 of T minus RTNDT.
4 MR. DICKSON: Yes.
5 DR. KRESS: The thing about the WIBLE is it
6 doesn't go out to infinity in both directions. It has a
7 lower bound and an upper bound.
8 MR. DICKSON: It's truncated on both ends.
9 DR. POWERS: Triangled.
10 MR. DICKSON: The WIBLE distribution -- I think
11 it's very -- the derivation is very --
12 DR. KRESS: It has several parameters. You could
13 make it flexible to fit.
14 DR. POWERS: The triangle has the same number.
15 DR. APOSTOLAKIS: It has three parameters, and
16 with three parameters, you can do a lot.
17 MR. DICKSON: The A, B, and C, the three
18 parameters of this distribution, are functions of T minus
19 RTNDT. So, when you say they're a function of T, that makes
20 them very much time-dependent in the analysis, because
21 temperature is changing through the wall.
22 RTNDT, as well as changing as a function through
23 the wall, it's changing as a function of when in the life of
24 the plant you're doing this analysis.
25 I will just say the final report on this -- there

1 was a few other considerations other than WIBLE considered,
2 and the report sort of discusses why the WIBLE distribution
3 was the template that was sort of chosen to put into this,
4 and certainly, one of them is that the WIBLE distribution, I
5 believe, was developed especially kind of for fracture-type
6 considerations.
7 DR. APOSTOLAKIS: It's distribution of minimum
8 values, is it not?
9 DR. WALLIS: This RTNDT sets the temperature
10 scale, doesn't it? If you slide horizontally, you can cover
11 a big range of points.
12 MR. DICKSON: Right.
13 DR. WALLIS: So, how well do you know this RTNDT?
14 MR. DICKSON: That's one of the variables that
15 there's an awful lot of sampling going on.
16 DR. WALLIS: That may be more important. The
17 uncertainty you show here looks good, but if you don't know
18 your RTNDT very well --
19 MR. DICKSON: The uncertainty of the RTNDT --
20 there's a lot of stuff going on inside of the analysis to
21 determine that.
22 I think Mark will talk about that.
23 RTNDT is a function -- you know, thinking back to
24 where we've talked all this about the discretization of the
25 vessel, the embrittlement -- when you talk about the

1 embrittlement, you're talking about the RTNDT, which is a
2 function of the chemistry.
3 DR. WALLIS: But someone who looked at these
4 points had to decided what RTNDT was in order to plot the
5 points? You could slide them around on that graph quite
6 easily by having a different RTNDT.
7 MR. DICKSON: There is actually a formula that
8 tells you what RTNDT is as a function of chemistry and
9 neutron fluence.
10 DR. WALLIS: Is it a real thing?
11 MR. DICKSON: It's a real thing, but there's a
12 distribution associated with that.
13 DR. POWERS: As you well know, Graham, they have
14 been researching this embrittlement since the dawn of time.
15 DR. WALLIS: Yeah. I'm just bringing out that
16 there's another uncertainty; it's not just the vertical
17 uncertainty.
18 DR. POWERS: And that raises the legitimate
19 question of these fitting processes.
20 If you fit one uncertain parameter versus another
21 uncertain parameter and you appeal to these squares, I will
22 throw things at you, because that's just not right.
23 Similarly, when I look at the calculations of the
24 parameters of the WIBLE distribution that are reported in
25 this document we've got, I am struck by -- you end up using

1 the database to find your means and your shape parameters
2 and shift parameters, at least when you calculate variances
3 of an ordinary database and you use the mean of the database
4 for the calculating of the variance, you introduce bias that
5 you have to correct for.
6 Don't you have to correct for bias when you do
7 these formulae using the database to define your parameters?
8 MR. DICKSON: Mark?
9 You're talking about the embrittlement correlation
10 itself.
11 DR. KIRK: I'm not sure I completely understood
12 that question. In fact, it would be fair to say I didn't.
13 But let me just address the gentleman's comment
14 over here.
15 In Terry's model, the uncertainty -- he's just
16 looking at part of it here.
17 Certainly, the uncertainty in the vertical axis is
18 considered, and this is the way it's currently been
19 characterized.
20 Equally, we've spent an awful lot of time -- and I
21 suppose you could say that's the main focus of the next
22 presentation -- in characterizing the RTNDT uncertainty.
23 That's a major component, as well.
24 With regards to the bias question, I'll invite Dr.
25 Powers to ask it to me again, but I would just like to

1 mention in passing that Terry's presenting here a purely
2 empirical model, just to fit the data, with absolutely no
3 appeal to any underlying physical theory.
4 In the presentation that I'll be making, which
5 concerns the uncertainty characterization of the K1C RTDNT
6 uncertainty model, we do appeal to, you know, physical
7 rationale and the underlying basis for cleavage fracture to
8 help us get at what these distributions should be, not just
9 argued from the data.
10 So, I realize that's not a direct answer to your
11 question, but I think that might help to put aside some of
12 the questions concerning lower tails and bias and things of
13 that nature.
14 DR. KRESS: I'd like to point out that these are
15 data taken from specimens, well characterized in terms of
16 RTNDT. The chemistry is well taken.
17 So, there's a relatively narrow uncertainty, but
18 when you get ready to decide what RTNDT is for the vessel
19 itself, so that you can select from the uncertainty there,
20 it's a much different uncertainty.
21 DR. WALLIS: That's a very helpful comment. Thank
22 you.
23 DR. POWERS: All except for the fact that -- yeah,
24 they're well characterized as far as chemistry and things
25 like that.

1 There is still an uncertainty in the RTNDT which
2 is non-trivial.
3 DR. KRESS: Oh, absolutely. It's non-trivial.
4 DR. WALLIS: How big is it?
5 DR. APOSTOLAKIS: If you know the RTNDT, there is
6 a spread of values for K. That's all he's telling you.
7 DR. KRESS: I think Dana has a valid point, that
8 how you get those variances and how they're distributed does
9 depend on both uncertainties.
10 DR. POWERS: Now, let's accept that we know RTNDT
11 exactly and we look at a vertical slice, a set of your data
12 points for a particular one, and you want to calculate the
13 parameters of the WIBLE distribution. Okay.
14 When you set out to do that, you need a mean, you
15 need something like a variance, and you need something like
16 a skew, because you've got three parameters you've got to
17 find, so you've got to take three moments of the
18 distribution to fit this thing.
19 When I use the data to calculate those things, if
20 I want to calculate the variance of a data set and I want to
21 take the moment around the mean, right, and I calculate that
22 mean from the data set and don't do something, I will
23 calculate a biased estimate of the variance.
24 It makes sense, because I've taken the data to
25 calculate the mean, and when I calculate the skew using the

1 mean of the data set to calculate the skew, I get a much
2 bigger bias, even, because I'm taking the third power of it.
3 Okay.
4 I didn't see, in your write-up in here, how you
5 accounted for that bias.
6 MR. DICKSON: Which write-up are you talking
7 about?
8 DR. POWERS: It was a document given to us that
9 goes through how you calculate the parameters of the
10 distribution.
11 MR. DICKSON: Okay.
12 DR. KRESS: I think that came from the University
13 of Maryland, didn't it, that particular document.
14 DR. POWERS: So, they're really biased. They're
15 biased clear over to the east coast.
16 DR. KRESS: Yeah. Doesn't even have an accent.
17 MR. DICKSON: There is a document that came from
18 Oak Ridge. I can't answer your question.
19 DR. SHACK: I would assume the statisticians took
20 that into account.
21 DR. WALLIS: There's another question, too. In a
22 finite number of data points, you start talking about
23 99.999.
24 Now, you need a certain number of data points
25 before you can even, with any precision, talk about that

1 sort of a number.

2 MR. DICKSON: Point well taken.

3 I believe that document talks about needing a

4 minimum of 250 to do the particular analysis that they did.

5 DR. WALLIS: And there's just about that here?

6 MR. DICKSON: Two hundred and fifty-four.

7 DR. WALLIS: So, just about enough to reach a .01-

8 percent conclusion.

9 DR. APOSTOLAKIS: What is the message you want to

10 leave us with?

11 MR. DICKSON: The only message here is that we

12 consider this an improvement over what we have been doing

13 for years.

14 DR. APOSTOLAKIS: What were you doing before?

15 MR. DICKSON: What we were doing for years was

16 taking the ASME curve and saying, by definition, it is the

17 mean minus 2 sigma, where 1 sigma was 15 percent of the

18 mean.

19 DR. APOSTOLAKIS: And the ASME curve was a curve

20 like the one there?

21 MR. DICKSON: The ASME curve actually was not a

22 lower-bound curve. It was actually a lower-bound curve to

23 about 88 percent of the data.

24 DR. APOSTOLAKIS: Okay. But it was a curve like

25 that.

1 MR. DICKSON: Yeah.

2 DR. APOSTOLAKIS: And now the new thing is the

3 uncertainty.

4 MR. DICKSON: Yes.

5 DR. APOSTOLAKIS: Through the WIBLE distribution.

6 MR. DICKSON: Yeah. So, we feel like this is a

7 more rigorous statistical model than what we had.

8 DR. APOSTOLAKIS: And why do you have this spread?

9 Why do you have uncertainty? Dr. Kress said earlier that

10 you had well-defined specimens.

11 DR. KRESS: Yeah. Those are not specimens, but

12 even those, whether or not K1C is an accurate

13 phenomenological description of cleavage fracture is

14 questionable. It depends on the geometry of the crack.

15 DR. APOSTOLAKIS: So, if I take 100 of those, I

16 will still have a spread.

17 DR. KIRK: The thing that lights off cleavage

18 fracture is the distribution of cleavage initiation sites or

19 generally carbides in front of the crack, and you've got big

20 carbides, you've got small carbides, and you've got a

21 massive stress gradient.

22 So, it's just a statistical process that sometimes

23 they light off early and sometimes they light off late.

24 DR. APOSTOLAKIS: So, this kind of an uncertainty

25 in understanding will be part of the bigger picture later

1 when you do the Monte Carlo study.

2 MR. DICKSON: Yes, absolutely.

3 DR. WALLIS: These specimens came from cutting up

4 a pressure vessel?

5 MR. DICKSON: No, not necessarily. Just from like

6 pressure vessel-type steel, A508, A533.

7 DR. WALLIS: That's not the same. It's been

8 treated differently than a pressure vessel.

9 MR. MAYFIELD: This is Mike Mayfield from the

10 staff.

11 The plate samples that were tested came from heats

12 of plate that were thermally treated to be identical to the

13 thermal treatments of reactor pressure vessels. They were

14 purchased from the mills that made the plates that went into

15 reactor pressure vessels, to the same specifications that

16 were used, and that thermal treatments were imposed to be

17 identical.

18 The weld materials that have been tested were used

19 -- were fabricated and heat treated using procedures that

20 were as close to those used in fabricating reactor pressure

21 vessels as was practical given that we're welding flat plate

22 rather than cylindrical shell segments.

23 So, there was some significant effort made to

24 duplicate the materials that would have actually been used

25 in fabricating reactor pressure vessels.

1 As we have had the opportunity to cut up some
2 pressure vessels, we have also been able to test materials
3 from actual reactor pressure vessels that never went into
4 service, and those materials fit in with these data quite
5 nicely.
6 So, there's good reason to believe that the data
7 we have are representative of the materials that were in-
8 service.
9 DR. KRESS: The fluence was provided over a
10 shorter period of time by putting them in a high flux
11 intensity area.
12 MR. MAYFIELD: The irradiation aspect of it from
13 the test reactors introduces some uncertainty in the
14 characterization, but the un-irradiated properties, the
15 materials themselves are quite representative.
16 DR. POWERS: Mike, have you ever found evidence of
17 a flux dependence?
18 MR. MAYFIELD: Yes. At the very high fluxes, we
19 used to do test reactor irradiations where the capsules were
20 put in core, and the flux there is high enough that we've
21 subsequently stopped doing that and we go out to the core
22 edge.
23 I've forgotten the numbers, but the in-core fluxes
24 were high enough that the theoreticians have shown us that
25 that was the wrong thing to do.

1 We've backed away from that, do core edge
2 irradiations now, so we can still get some acceleration, but
3 it's not so high as to be of concern.
4 DR. SIEBER: Is there a dependency on the energy
5 level of the fluence?
6 MR. MAYFIELD: Yes, but for the range of fluences
7 -- I'm sorry -- for the energy spectra that we typically see
8 in power reactors, there is not such a large spectral
9 difference for it to be an issue, and as long as we capture
10 the neutron flux above 1 MEV, that's where the index -- it's
11 a convenient index to use, and that's where the modeling has
12 been done.
13 DR. SIEBER: But through-wall, there should be a
14 lot of attenuation, so there should be a variation in RTNDT
15 through the wall.
16 MR. MAYFIELD: There is absolutely a lowering of
17 the RTNDT as you go through-wall, and that is accounted for
18 in Terry's analyses through this attenuation parameter. So,
19 he's attenuating the fluence as he goes through-wall and
20 then can calculate an RTNDT, an adjusted RTNDT as a position
21 of -- as a function of position.
22 DR. SHACK: But you don't, for example, take into
23 account the spectral change as you go through the wall.
24 MR. MAYFIELD: No.
25 DR. SIEBER: Is that important?

1 MR. MAYFIELD: Over the ranges we're talking
2 about, it's not a factor.
3 DR. SIEBER: All right. Thank you.
4 DR. KIRK: This is Mark Kirk from the staff.
5 It might also be helpful to point out in passing
6 that a lot of the questions that were just asked in the past
7 few minutes regarding irradiation effects and materials
8 effects all manifest themselves in a change in the index
9 temperature parameter, RTNDT.
10 They do not manifest themselves at all in a change
11 in the vertical scatter.
12 So, those uncertainties, material dependent
13 differences and so on, are there and are considered, but
14 they're taken up in a different part of the analysis.
15 DR. SIEBER: Thank you.
16 MR. DICKSON: Okay.
17 This is just to maybe graphically illustrate, you
18 know, an inner surface-breaking flaw as well as the embedded
19 flaw, and the FAVOR code -- traditionally, the older FAVOR
20 codes only did surface-breaking flaws, and as I said
21 earlier, when they actually start doing destructive
22 examination, non-destructive, destructive examination, they
23 hadn't found any of these, but they found a ton of these.
24 So, the FAVOR code -- and the -- actually, the
25 mechanics that you have to do to deal with these flaws is

1 dramatically different than the mechanics that you have to
2 do to deal with these flaws, but the FAVOR code now will
3 deal with either/or, you know, within the same analysis.
4 You can have inner surface-breaking and/or embedded flaws in
5 the same analysis.
6 DR. WALLIS: There's an infinite variety to flaws,
7 all kinds of flaws.
8 MR. DICKSON: Oh, yeah.
9 DR. WALLIS: Once you have a flaw, its shape and
10 everything is -- it's like a snowflake, isn't it? I mean
11 they're all different.
12 MR. DICKSON: Yeah, sort of.
13 DR. WALLIS: But somehow you can treat them all -
14 -
15 MR. DICKSON: No.
16 Within the analysis -- I mean the things that get
17 sampled within the analysis is the -- what we call the
18 through-wall depth -- in other words, how deep is the flaw,
19 how long is the flaw, where is the flaw, is this type flaw
20 or this type flaw, where through the wall.
21 All of those things are sampled, and the functions
22 that they're sampled from are the characterization data that
23 has been found in PVRUF, as well as the work that's being
24 done here at the NRC to characterize the flaws.
25 DR. WALLIS: Are they typically very small things?

1 MR. DICKSON: Yes, for the most part.

2 DR. WALLIS: What sort of size?

3 MR. DICKSON: Let me answer it this way.

4 I think the largest flaw that has been found in
5 this actual effort of going and cutting this vessel material
6 up, the largest flaw that's been found is an embedded flaw
7 that's 17 millimeters through-wall extent. How long it was,
8 I actually don't know.

9 We found a whole lot more flaws than was used, not
10 so much smaller, they were just in the wall, and from a
11 fracture mechanics point of view, this flaw was a whole lot
12 more benign than this flaw.

13 DR. SIEBER: On the other hand, there is a
14 critical flaw size where propagation occurs, which is a
15 function of RTNDT.

16 MR. DICKSON: Well, it's a function of everything.
17 It's a function of the embrittlement, it's a function of the
18 transient.

19 DR. SIEBER: Right.

20 MS. JACKSON: This is Debbie Jackson from the NRC
21 staff.

22 To date, the largest flaw that PNNL has found,
23 like Terry said, was 17 millimeters, and it was
24 approximately, I believe, 5 millimeters long, but they found
25 some other flaws in other vessel material.

1 We're doing Shoreham, River Bend, and Hope Creek,
2 and we found some flaws, but they haven't been validated,
3 that are a little longer than 17 millimeters.
4 MR. DICKSON: So, if you remember that box that I
5 showed, all the things feeding into the middle, one of them
6 was flaw characterization, and that's a pretty general term.
7 It's how many flaws, what characteristics, you know, how
8 long, how deep, where in the wall, all of that gets into the
9 analysis.
10 DR. SIEBER: I presume that the flaws that have
11 been found are not uniformly distributed through the wall.
12 MR. DICKSON: Debbie can speak to that better than
13 I can.
14 MS. JACKSON: This is Debbie Jackson again.
15 The majority of the flaws have been found in weld
16 repair regions, regions of the welds that have been
17 repaired, and we're presently doing some additional exams on
18 the base metal.
19 MR. DICKSON: I believe you asked are they
20 uniformly distributed through the thickness of the wall --
21 DR. SIEBER: Yes.
22 MR. DICKSON: -- and I believe the answer is
23 approximately.
24 MS. JACKSON: Right, where a weld repair is
25 located, right.

1 There are a lot of smaller flaws.

2 MR. DICKSON: Okay.

3 I'm going to have one slide here, just a little

4 bit about the structure of FAVOR, which I don't know if

5 that's real important here, but we'll talk about it anyway.

6 When we talk about the FAVOR code, I don't know

7 what people conjure up in their mind.

8 This code -- the current code that we're working

9 on consists of three separate, independent modules.

10 The first one is -- and I'll talk a little bit

11 more about these on subsequent slides. The first one is a

12 load generator, and the input -- this first level, the blue

13 boxes up here, is input data. These yellow boxes -- they're

14 the actual executable modules. So, when you talk about

15 FAVOR, this is what you're talking about, and this last row

16 here is what comes out of each of the modules.

17 So, your first one is your load generator. That's

18 where you actually put in your thermal hydraulic boundary

19 conditions from, typically, like this output from the RELAP

20 code, and of course, you input your thermal elastic material

21 properties for the clad base material, elasticity, thermal

22 conductivity, coefficient of expansion, on and on, the RPV

23 geometry.

24 Now, a transient description -- typically, it will

25 come in the form of three time histories, the pressure time

1 history that's acting on the inner surface of the vessel,
2 the coolant temperature time history, and the convective
3 heat transfer coefficient.
4 Now, each one of these, you can input 1,000 time
5 history pairs for each of the three, and typically, I think
6 the people from the thermal hydraulics branch told me that,
7 for Oconnee, there's 27 transients. So, you're talking
8 about 81,000 time history pairs.
9 So, again, big bookkeeping exercise, as well as
10 doing the mechanics.
11 Out of this comes the through-wall temperature
12 gradient as a function of location and time, stresses, and -
13 -
14 DR. WALLIS: I think it would be XYZT.
15 MR. DICKSON: This is an axial symmetric. It's a
16 one-dimensional analysis through the wall.
17 DR. WALLIS: That's all?
18 MR. DICKSON: Yeah. Since we are assuming that
19 the thermal hydraulic boundary conditions are axial
20 symmetric, you only need a one-dimensional analysis.
21 DR. WALLIS: You don't need a vertical coordinate,
22 too?
23 MR. DICKSON: No.
24 Okay.
25 So, you run this module, and out of that comes a

1 file that contains all of this.

2 DR. WALLIS: If the thermal hydraulic tests showed

3 plumes, you'd have to change this into something different.

4 MR. DICKSON: Yeah, if it showed that they were

5 very significant.

6 DR. WALLIS: Now, is FAVOR able to do that?

7 MR. DICKSON: We would have to re-do this aspect

8 of it, not the whole thing.

9 DR. WALLIS: You'd have to re-do that part of it.

10 MR. DICKSON: We would have to do that part of it.

11 It would not be trivial.

12 Essentially, instead of doing a one-dimensional

13 finite element analysis, we would have to do a three-

14 dimensional finite element analysis.

15 DR. WALLIS: In order to be cautious, you might

16 want to do an XYT one just to see what happened if you did

17 have a plume, even if you had reason to hope it wasn't

18 there.

19 MR. DICKSON: We have some publications on that.

20 Actually -- I want to digress too far on this.

21 In the first two versions of FAVOR that came out,

22 the '94 and '95 versions, there actually was a option in

23 there to include this, and in a conservative sort of way, in

24 a bounding sort of way.

25 So, we really did get in and do a lot of analysis,

1 but when we went to this next version, the decision was made
2 early on that we're not going to do that.
3 Now, if APEX shows that this could be very
4 significant, we may have to go back and do that.
5 Anyway, load-generator --
6 MR. MAYFIELD: This is Mike Mayfield from the
7 staff.
8 This was something that we had some considerable
9 debate on, and we recognize there is an element of gambling
10 here that -- on what the APEX results will show us, but when
11 we looked at the other analyses that had been done, we took
12 a deep breath and said let's move forward, but at the same
13 time perform the experiments to try and sort it out, and if
14 we guessed wrong, then we're going to have to do some
15 additional work, and we'll have to deal with the schedule
16 impact, but we went into it recognizing there was an element
17 of risk that we would have guessed wrong.
18 DR. WALLIS: Well, computationally, doing XYZT
19 isn't that complicated, just you've got to do so many runs?
20 Is that what it is?
21 MR. DICKSON: No. I mean what you're talking
22 about -- if these plumes, which are multi-dimensional by
23 nature -- if they are significant, you can no longer do a
24 one-dimensional axial symmetric analysis.
25 DR. WALLIS: That's right.

1 MR. DICKSON: And as I'll talk about in a moment,
2 we do finite element analyses.
3 So, writing a finite element code --
4 DR. WALLIS: It's not that difficult to do.
5 MR. DICKSON: Well, it's like everything here.
6 The devil is in the details. Writing a three-dimensional
7 finite element code is not a trivial -- it's not something
8 you do in an afternoon.
9 MR. MAYFIELD: I think the other thing we've
10 talked about is we would have to look at some -- perhaps
11 some simplifying approaches to the stress analysis, which
12 would take us to a little bit different structure in this
13 particular module.
14 MR. DICKSON: Yeah, it might.
15 MR. MAYFIELD: So, we could very well end up
16 having to do some things off-line and then load in stress
17 information, but there are other approaches that could be
18 considered rather than the approach that Terry has been able
19 to make use of given the one-dimensional nature of the
20 problem.
21 But your questions are -- we agree completely.
22 Some of us that were involved in making that decision are
23 waiting quite anxiously to see how close we were or weren't
24 to being right.
25 MR. DICKSON: Again, I'll refer back to some of

1 Theofanis' publications saying that, for U.S. domestic
2 commercial designs, it should not be significant. So, I
3 guess we're putting some faith in that.
4 Okay.
5 Then here's the probabilistic fracture mechanics
6 module, and the input to that is all of the flaw data,
7 which, again, tells you the densities, number of flaws, as
8 well as the size and location.
9 Also coming into this PFM module is the
10 embrittlement data. You remember that, where I showed the
11 vessel rolled out from zero to 360 degrees. Each one of
12 those little regions has a particular chemistry and neutron
13 fluence, something that gives you enough information to
14 calculate the RTNDT of each one of those regions.
15 Okay.
16 And also, of course, the loads from the load
17 generator -- all this obviously is input into here.
18 DR. WALLIS: The belt-line embrittlement isn't
19 one-dimensional either.
20 MR. DICKSON: No.
21 DR. SIEBER: Well, you aren't really talking about
22 belt-line. You're talking about the whole show, right?
23 MR. DICKSON: We're talking about the entire belt-
24 line region. It's two-dimensional.
25 DR. WALLIS: How do you do that two-dimensionally

1 and do the stress one-dimensionally?

2 MR. DICKSON: Well, it's just the same stresses

3 are assumed.

4 DR. WALLIS: Okay. I guess it is independent.

5 It's all independent.

6 MR. DICKSON: Yes.

7 DR. WALLIS: Yeah, I guess that's right.

8 MR. DICKSON: The assumption is that the stress

9 profile acting through the wall here is the same as it is

10 anywhere else, and the temperature profile through the wall,

11 which is a totally independent assumption from what the

12 embrittlement is in any location.

13 Okay.

14 DR. WALLIS: So, embrittlement doesn't change the

15 modulus.

16 MR. DICKSON: No. The modulus of elasticity? No.

17 DR. WALLIS: For the stress calculations.

18 MR. DICKSON: Embrittlement changes the yield

19 strength a little bit, but basically, we're doing --

20 DR. WALLIS: No, it doesn't change it.

21 MR. DICKSON: No, it doesn't change the modulus,

22 no. It changes the yield stress some, but we're doing a

23 linear elastic analyses here. We're not doing elastic

24 plastic analyses.

25 DR. WALLIS: Never get that close. Never get

1 close to that, do you?

2 MR. DICKSON: No, there are cases where you can

3 get into plasticity, but the assumption traditionally has

4 been that a LEFM analysis is conservative, as opposed to

5 where you actually consider the plasticity.

6 DR. WALLIS: Once it begins to fail.

7 MR. DICKSON: I think we're going to have to take

8 a closer look at that when it comes to embedded flaws. You

9 know, for surface-breaking flaws, I think, traditionally,

10 it's been shown that, if you do a LEFM analysis, linear

11 elastic fracture mechanics analysis, that that is

12 conservative with regard to surface-breaking flaws, but for

13 embedded flaws, I don't think we at Oak Ridge are yet

14 convinced that that is necessarily the case.

15 MR. MAYFIELD: Terry, this is Mike Mayfield again.

16 For surface-breaking flaws, we've shown it to be

17 accurate.

18 MR. DICKSON: Yeah.

19 MR. MAYFIELD: It correctly characterizes the

20 phenomenology for a highly-embrittled pressure vessel at the

21 surface, and if you have a less-embrittled pressure vessel

22 such that you actually had to go to an elastic plastic

23 analysis, by and large pressurized thermal shock wouldn't be

24 an issue.

25 So, what you're really talking about is the set of

1 conditions that gets you to a linear elastic fracture
2 phenomena.
3 So, it's not just that it's conservative. It is,
4 in fact, accurate for the surface-breaking flaws.
5 As Terry says, for the embedded flaws, it gets a
6 little more interesting, but by and large, if it's an
7 elastic plastic initiation, it's not much of a challenge
8 from pressurized thermal shock.
9 MR. DICKSON: So, out of this PFM module comes
10 actual distributions for the conditional probability of
11 initiation -- in other words, the conditional probability
12 that you initiate a flaw in cleavage fracture, the
13 conditional probability of failure.
14 In other words, just because you initiate a flaw
15 does not necessarily mean it's going to propagate all the
16 way through the wall.
17 There's another analysis that has to be done to
18 determine whether that flaw that initiates actually goes
19 through and makes a hole in the side of the vessel.
20 So, for each transient, what comes out of here is
21 the distributions for the conditional probability of
22 initiation, conditional probability of failure for each
23 transient.
24 Okay.
25 Now, this third box over here -- this is actually

1 the one I'm working on right now, as we speak, as far as the
2 development aspect.
3 The input into this, of course, is these
4 distributions for the conditional probability of initiation,
5 conditional probability of failure, and I keep using the
6 word conditional.
7 It's conditional that the transient occurred,
8 okay, but input here is actually the distribution of the
9 initiating frequencies, initiating frequency being, you
10 know, how often this transient occurred.
11 DR. APOSTOLAKIS: So, the transient does not
12 appear for the first time there.
13 MR. DICKSON: Yeah. The transient as a thermal
14 hydraulic boundary condition that actually occurs is back
15 over here.
16 You go ahead and calculate, if this transient
17 happens, here's the result.
18 Here's the actual probability of the transient
19 even happening to begin with.
20 And I'll talk briefly in a couple of slides here
21 about how these distributions and these distributions get
22 together to form this final distribution, which is the
23 frequency of RPV fracture, or in other words, the crack
24 initiation, the frequency that you fracture the vessel and
25 also the frequency that you fail the vessel.

1 DR. WALLIS: These transients you start with are
2 some sort of design basis accident?
3 DR. SIEBER: Not necessarily.
4 MR. DICKSON: Not necessarily. I don't feel like
5 I'm probably the person to speak to the thermal hydraulics
6 aspect of it.
7 MR. CUNNINGHAM: This is Mark Cunningham from the
8 staff.
9 You don't start from the set of traditional design
10 basis accidents that are in Chapter 15 and that sort of
11 thing. You start from -- you look at information on what
12 types of transients in the plants can cause issues of
13 concern.
14 DR. WALLIS: Okay.
15 MR. CUNNINGHAM: Over-cooling, pressurization.
16 So, it can be small-break LOCAs with operator actions, it
17 can be a variety of things like that, but it doesn't start
18 from the Chapter 15 analysis.
19 DR. KRESS: It's a selection from the normal PRA
20 of those sequences that might be important.
21 MR. CUNNINGHAM: Yeah. Somebody when we talk
22 about the PRA, you'll see we look at PRA information, we
23 look at operational experience and that sort of thing, to
24 see what's going on and what could cause these types of
25 situations in the plant, in the vessel.

1 DR. SHACK: Now, when you do the running crack,
2 it's running one-dimensionally, right? You're not trying to
3 also do a length-growth of this thing, or are you?
4 MR. DICKSON: No.
5 The assumption is that -- and this is consistent
6 with experimental results that we've observed through the
7 years at Oak Ridge, is that an initiated flaw runs long
8 before it runs deep, propagates along the length of the
9 vessel before it propagates through the wall.
10 So, you could start with -- you could thermally
11 shock this vessel right here with this flaw, and this flaw
12 is going to want to extend this way before it goes through
13 the wall, and also, with this flaw, the assumption is that
14 this flaw is going to propagate in toward the inner surface,
15 because it's propagating into a region of higher
16 embrittlement, as well as higher stress, so it's got a
17 higher load and a lower material resistance in this
18 direction.
19 So, the assumption -- you check it at the inner
20 crack tip, you check it for initiation, you know, and if it
21 initiates, you assume that it breaks through and becomes
22 long.
23 So, an initiated flaw is a long flaw, becomes a
24 long flaw.
25 Then the question is, now, do you, the long flaw,

1 do you propagate through the wall?

2 DR. POWERS: Do you get a damage accumulation in

3 these processes? That is, if I do a little bit of insult,

4 little bit of over-cooling, I get my cracks bigger and

5 bigger and bigger?

6 MR. DICKSON: No. No, there's no -- I think Mike

7 Mayfield mentioned a moment ago, there's no service-induced

8 crack growth here.

9 If the flaw is predicted to crack, it's predicted

10 to be a major -- I mean it runs long and breaks through.

11 DR. KRESS: You don't use the time-dependent flaw

12 distribution, is what you're saying.

13 MR. DICKSON: Yeah. There is no time-dependent

14 flaw distribution.

15 DR. POWERS: I'm asking about the phenomenology

16 here.

17 DR. SIEBER: Well it would seem to me that you can

18 initiate a crack through some event that arrests, and then,

19 as the vessel runs again, you continue to embrittle it so

20 that the next event you have, it can go even further, and I

21 guess that's what in-service vessel inspection's all about,

22 to try to find those situations, if you can.

23 MR. MAYFIELD: This is Mike Mayfield from the

24 staff.

25 I think the notion is that if, in fact, you had a

1 substantive over-cooling, you have to go back and inspect
2 the vessel.
3 So, there would be -- you would intend to go look
4 for anything that you might have popped in. There's always,
5 of course -- in-service inspection or non-destructive
6 examination is not 100-percent.
7 So, there is the potential that you could have a
8 pop-in that you would miss, but -- it's not inconceivable,
9 but we think that the prospect of that is not all that high.
10 First of all there aren't that many highly-embrittled
11 vessels out there.
12 But I think your point is correct.
13 DR. SIEBER: If you were to do an inspection, what
14 is the minimum flaw size you can characterize? Could you
15 find these 17-millimeter flaws?
16 MR. MAYFIELD: Yes. If you know to go look for
17 them.
18 So, it gets to be a question of what would you ask
19 the inspectors to do? You probably would not send them out
20 and ask them to do a traditional Section 11 in-service
21 inspection.
22 So, it's a question of what you would actually --
23 what a licensee would actually ask their in-service
24 inspection team to go look for.
25 I guess I should also say that the

1 characterization, the flaw characterizations that Terry
2 talked about and that Debbie Jackson mentioned started out
3 with ultrasonic examination.
4 It's some fairly sophisticated ultrasonic
5 examination, but that's where it starts, followed up by
6 destructive examination.
7 DR. SHACK: Now, presumably you have done the
8 fracture -- the fatigue flaw growth to convince yourself
9 that these things really don't grow by fatigue.
10 MR. MAYFIELD: This is something that a lot of us
11 used to make our living trying to do, and this comes up --
12 everybody that looks at PTS wants to go do a fatigue crack
13 growth evaluation, and they consistently come back with the
14 same answer, that it's a no-never mind, and the reason is
15 the normal operating stresses are so low, even if you had a
16 surface-breaking flaw, the cyclic component of normal
17 operation is so low and these flaw sizes are so small, you
18 get just no growth.
19 MR. DICKSON: I guess, before I move on to the
20 next slide, the main purpose of this slide -- a main purpose
21 of this slide is that the bottom line, what comes out of --
22 after you run all three of these modules of FAVOR, the
23 bottom line is a frequency, a distribution of the frequency
24 of how often you fail the vessel, and that distribution has
25 a mean value which you would then go plot on that curve that

1 I showed early in the presentation, you know, let's say that
2 we're doing this at 32EFPY.
3 So, each time in the life of the plant has a
4 distribution of failure associated with it, which has a mean
5 value, which you would go back and plot on the curve I
6 showed, and of course, there would be a distribution.
7 DR. APOSTOLAKIS: It's not clear a priori that it
8 will work with a mean value. I mean it depends how wide the
9 distribution is.
10 MR. DICKSON: Right.
11 DR. APOSTOLAKIS: So, I understand we have a
12 subcommittee meeting coming up, and we'll talk about how all
13 these uncertainty calculations are being done. Is that
14 correct?
15 MR. DICKSON: Yes.
16 MR. HACKETT: Professor, I think we were talking
17 in December, most likely.
18 This is Ed Hackett from the staff.
19 DR. APOSTOLAKIS: I thought it was November 16th.
20 That's not true anymore?
21 MR. HACKETT: Terry, this is Ed Hackett. I was
22 going to suggest, in the interest of time, because we're
23 running a bit behind here -- I think you made a good
24 jumping-off point to go to your slide 19, the second-to-
25 last. Why don't we just go to that?

1 DR. WALLIS: I have a point on number 17. You are
2 actually looking at uncertainty in the thermal hydraulics by
3 varying some of the parameters in that in a statistical
4 random way or something?
5 MR. DICKSON: Do you want me to jump to the last
6 slide?
7 The answer is yes, this is an attempt to capture
8 the uncertainty associated with the thermal hydraulics.
9 DR. WALLIS: And you're getting some good
10 consulting on that or something from somebody?
11 MR. DICKSON: This is an interface between the PRA
12 people and the thermal hydraulics people.
13 DR. WALLIS: They have a good way of estimating
14 uncertainties in the thermal hydraulics?
15 MR. CUNNINGHAM: In the PRA part of this, this has
16 been one of the challenges, how do you bring that together.
17 This will be one of the subjects we'll talk about, I guess,
18 at the December meeting.
19 DR. WALLIS: I think it's important to do. I just
20 wondered if anybody knew how to do it well.
21 MR. CUNNINGHAM: We'll see, but we think we can do
22 it with a fair amount of comfort on our part.
23 DR. WALLIS: Let's hear about that at some point.
24 MR. CUNNINGHAM: Yes, in December.
25 MR. DICKSON: Well, this is just an attempt to

1 show that we have major categories of transient.

2 Maybe this is a LOCA, and within that LOCA, there

3 are several variants of that, and each one of them has a

4 certain frequency of occurrence, a distribution of the

5 frequency of occurrence, which we talked about.

6 All this feeds into this load generator of FAVOR,

7 which performs a one-dimensional, axial symmetric, finite

8 element thermal analysis as well as a finite element stress

9 analysis, and as I showed a moment ago, the output from that

10 is a lot of temperatures, stresses, and stress intensity

11 factors, and I'll try to be real brief here. I've got two

12 more slides.

13 This is, again, talking about this probabilistic

14 fracture mechanics module.

15 Again, this is redundant. The input data coming

16 into this is all the flaw data, the embrittlement map, as

17 well as some uncertainty, 1 sigma values, as well as the

18 loads, and what comes out of that is an array -- this is for

19 -- I call this PFMI. This is for initiation, as opposed to

20 PFMF, which is conditional probability of failure.

21 So, what comes out this PFM module is like a two-

22 dimensional array for so many vessels and so many

23 transients, okay?

24 Now, I know this maybe is a little bit not clear

25 at this point, but let's just say that each entry in this

1 matrix is the conditional probability that that vessel
2 initiated or failed when subjected to that particular
3 transient, okay?
4 So, we end up with these two arrays.
5 Now, it would be another whole presentation to
6 talk about the actual details of what goes into calculating
7 that the -- the probability that that vessel fractured when
8 subjected to that transient, and we're not going to go there
9 in this presentation, because we don't have time.
10 So, this is the last slide, but I think that is
11 one of the things, when we get together for this meeting of
12 uncertainty, that we will talk in great detail about, and
13 this is the post-process, just trying to graphically show
14 how we integrate the uncertainties of the transient
15 initiating frequencies with the PFMI and PFM arrays that I
16 just showed, which is what comes out of your probabilistic
17 fracture mechanics analysis, to generate distributions for
18 the frequency of RPV fracture and failure.
19 This is an attempt to show the distribution of the
20 initiating frequency for transient one-two-dot-dot-N that
21 feeds in here, as well as the arrays that were calculated
22 from the probabilistic analysis.
23 And this is showing -- here's the bottom-line
24 answer that comes out of this, which is the frequency of RPV
25 fracture, and what you do to actually generate this

1 distribution is, for each vessel -- keep in mind, we're
2 going maybe 100,000 or a million vessels, this is a Monte
3 Carlo process, so we sample each one of these distributions
4 to get a frequency for each of the transients, and then we
5 combine that with the results of the PFM analysis where the
6 conditional probability of failure for a vessel is the
7 summation of the products of the initiating frequency with
8 the conditional probability of fracture for that vessel.
9 So, what you're multiplying here is events per
10 year, failure per event, which is failures per year. That's
11 what you end up with.
12 I mean this looks kind of difficult but it's
13 really just pretty straightforward.
14 At the end of the day, you end up -- let's say you
15 end up with a million of these values, which you then sort
16 and then generate this distribution, which has some mean
17 value and some level of uncertainty about it.
18 So, that's the bottom line.
19 DR. WALLIS: This is all what you intend to do.
20 This is all the specifications for FAVOR.
21 MR. DICKSON: Yeah, this is the specifications,
22 and basically, the first two modules are pretty complete,
23 although there's a lot of details that are still up for
24 grabs. This third module, I'm developing that right now.
25 DR. UHRIG: What's the abscissa here in the lower

1 graph?

2 MR. DICKSON: This would be frequency of failure,

3 the frequency of the frequency. So, it's a histogram.

4 It's the frequency of the frequency. Did you

5 follow that?

6 I mean what we're talking about here is the

7 frequency of RPV fracture, so many fractures per year, and

8 then a histogram, by its very definition, is the relative

9 frequency or, if you wish, the density of something. So,

10 you can think of it as the relative frequency or the density

11 of the frequency of fracture.

12 Is that clear? It's a lot of words. I can see

13 why it might not be.

14 This is just a histogram or a distribution of the

15 frequency of vessel failure.

16 DR. WALLIS: What is your specification for how

17 long it takes to run this?

18 MR. DICKSON: Well, it takes a while.

19 DR. WALLIS: It's not much use if it takes a year.

20 MR. DICKSON: No, no, it doesn't take a year, but

21 to run like 25 transients for many 100,000 vessels, on a

22 machine that I have in my office, which is 533 megahertz --

23 it was the newest machine a year ago -- it's an overnight

24 job.

25 DR. WALLIS: That's not so bad.

1 MR. MAYFIELD: Dr. Wallis, in comparison to the
2 big system-level thermal hydraulics codes, this thing is a
3 blink of the eye.
4 It runs very quickly relative to some of the large
5 codes.
6 DR. WALLIS: So, the inputs you're getting from
7 RELAP will be the bottleneck, then.
8 MR. DICKSON: Yeah, I guess so.
9 DR. WALLIS: So, maybe we should work on the
10 bottleneck.
11 [Laughter.]
12 DR. POWERS: You began this session by saying to
13 us that thermal hydraulics had not improved yet. Let's work
14 on the part that's improved, and that's the fracture
15 mechanics.
16 MR. MAYFIELD: If we don't have any other
17 questions for Terry, I guess I would -- we have a second
18 presentation, looking at the materials, and I guess the
19 question I would pose to the committee is, do you want us to
20 try and stay within the time slot, or do you want Dr. Kirk
21 to give you the presentation, or some variant on that?
22 DR. POWERS: I believe you have till 20 of the
23 hour. If he does what he professes to do, persuade me that
24 the WIBLE distribution has a theoretical foundation, he has
25 till midnight.

1 [Laughter.]

2 MR. MAYFIELD: Let me assure you, sir, there will

3 be those of us that get the hook long before midnight.

4 Mark, why don't you try and stay within the time

5 slot?

6 DR. KIRK: I'll try to keep it snappy.

7 Okay.

8 Well, this is just one part of many parts of

9 Terry's overall calculation, and the goal in this effort is

10 to characterize toughness using all available data,

11 information, in a way that is PRA-consistent, and what I

12 mean by that, before I get shot down by the whole committee,

13 is a best estimate process, and that, as you'll see here, is

14 actually quite a remarkable change from where we've been

15 before.

16 The process that we've gone through is, first off,

17 to start with a data evaluation, and we asked Terry's

18 colleagues at Oak Ridge to assemble all of the available

19 valid -- and by valid, I mean linear elastic valid K1C and

20 K1A data. Terry showed you that.

21 They did a purely statistical analysis of the

22 data, for what it's worth, but we wanted to start with the

23 largest empirical database possible.

24 That information was then passed to Dr. Modarres

25 of University of Maryland and Dr. Natishan of PAI to help us

1 establish the sources of uncertainty.

2 They performed a root cause analysis, which I'll

3 go through in some level of detail, and appealed to a

4 physical basis for the process of cleavage fracture to help

5 us to distinguish in this overall process of both RTNDT

6 uncertainty and fracture toughness uncertainty what parts of

7 those uncertainties are aleatory and epistemic and what's

8 the proper way to account for them in the probabilistic

9 fracture mechanics calculation.

10 Professor Modarres and his students developed a

11 mathematical model to treat the parameter and model

12 uncertainty which is currently -- we're working the bugs out

13 of that but is currently being coded into FAVOR.

14 So, that's the ultimate end result of all this, is

15 a description of initiation fracture toughness and arrest

16 fracture toughness in FAVOR that accounts for all the

17 uncertainties in an appropriate way.

18 Terry showed you -- this is in your slides. Terry

19 showed you the database before.

20 This just points out that there was some data

21 growth from where we were in both the crack initiation and

22 crack arrest data, and it also points out that the bounds on

23 the curves that we were using before in the SECY 82-465 and

24 in the IPTS studies, which are shown in red, are

25 considerably different than the bounds that we're using now,

1 but of course, that all goes into the mix and you turn the
2 crank.
3 And as is noted on the bottom in yellow, the
4 implications of that increase in uncertainty -- and here you
5 should really just be looking at the vertical axis
6 uncertainty, because that's all that is reflected on this
7 slide -- really depends upon the transient considered.
8 Terry has done some scoping analyses which reflect
9 that and, I believe, were published in a pressure vessel and
10 piping conference publication.
11 The analysis process that Drs. Natishan and
12 Modarres used, we've been referring to as a root cause
13 diagram analysis, and the nice thing about this, at least
14 from my perspective as a participant in the process, is it
15 really -- it's a visual representation of a formula, but it
16 can be a very complex formula, and it helps to both build
17 consensus among the experts and it also provides a common
18 language for discussion between the materials folks and the
19 PRA folks.
20 One thing that's very nice about it is it helps us
21 to position -- everybody's got their most important variable
22 -- the fluence folks, fluence is most important; the
23 materials folks like myself, copper is most important.
24 They're all, of course, very important, but they
25 enter the process in different places, and you need to get

1 the parameters or the boxes -- or you could think of those
2 as distributions of variables -- and then the relationships
3 between the variables are shown at the nodes.
4 So, you can imagine here -- and I'll show you an
5 actual example of one of these in a minute -- putting in
6 copper and nickel and initial RTNDT on this side and
7 propagating through a mathematical model and coming out with
8 a distribution of RTNDT which then samples a K1C
9 distribution on the other side.
10 One big change from the old way of doing this --
11 by the old way, I mean in the IPTS studies and in SECY 82-
12 465 -- that this process represents is that here we -- as I
13 just mentioned, we input the uncertainties in the basic
14 variables -- copper, nickel, initial mechanical properties
15 and so on -- and propagate those to output uncertainties,
16 ultimately, RTNDT or somewhere way over there, probability
17 of vessel failure.
18 What we don't do, which is what we used to do, is
19 to input the margins or the uncertainties from outside the
20 analysis.
21 That's what happened before. We had -- for
22 example, for the embrittlement trend curve, we had a bit of
23 uncertainty of -- a standard deviation of -- it was 28
24 degrees Fahrenheit on welds.
25 So, that became one of the parameter boxes that

1 was applied, rather than letting the analysis figure it out
2 from copper and nickel and so on.
3 The other thing that this provides us, which sort
4 of goes to the end application of all of this work, is in
5 the end, of course, we're trying to figure out a new PTS
6 screening criteria that we can compare plants to.
7 When we compare plants, at least in the current
8 way of doing things, we generate a best estimate -- in this
9 case, RTNDT -- and then we add a margin to it.
10 As I stated now, right now, the margin was sort of
11 decoupled from this process, whereas here, the margin is
12 determined through the process.
13 So, in that way, it's much more self-consistent
14 than it was in the past.
15 Now, this has enough details to keep us here till
16 midnight, and we can do that if I'm allowed to make a phone
17 call and get my son to football, but what I'd like to do is
18 to just make a few points and then open it up to questions
19 if you all have any.
20 I should note that information flow on this
21 diagram goes from right to left rather than left to right,
22 but what we've done is we've diagrammed or mathematically
23 modeled a process that's fully consistent with the current
24 regulatory framework for establishing an estimate of the
25 fracture toughness of the vessel at end-of-license fluence.

1 So, you start somewhere back here.

2 Now, you see, I haven't shown you everything,
3 because the sharpie embrittlement shift, the delta-T 30 goes
4 to a completely other view-graph which has its own set of
5 information and fluence and through-wall attenuation and all
6 of that.

7 The diagram that you see here is all of --
8 everything that feeds into node 3 is just the process by
9 which we estimate RTNDT un-irradiated for a particular
10 material in the vessel, and this is the diagrammatic
11 representation -- don't be too alarmed -- of what's actually
12 in SECY 82-465 or Reg. Guide 1.99, Rev. 2.

13 So, anyway, you put in all the variables, and what
14 this treats is different levels of knowledge.

15 Sometimes you have specific material properties
16 for a specific weld. Other times you have to use generic
17 data. Other times you might have only some information.
18 But in any event, you propagate that all through, you get an
19 estimate of RTNDT un-irradiated.

20 You add to that an estimate of the sharpie shift.
21 You then get an estimate of RTNDT irradiated, and then I
22 guess I wish to make the third point second, because I'm at
23 that node.

24 When we get RTNDT irradiated -- and this is what
25 came up before -- is there is a recognition here -- and I

1 think I'll go to the next slide and then come back, and this
2 is, again, a new feature of this analysis.
3 There's a recognition here that RTNDT -- that the
4 RTNDT value, which serves as an indexing parameter for
5 placing -- here I've just shown a bounding curve, but
6 equally, it can position a family of curves or a density
7 distribution.
8 There's the recognition that RTNDT sometimes does
9 a pretty good job at predicting where the transition curve
10 lies with relation to real data, and here we're taking the
11 linear elastic fracture toughness as our version of reality,
12 and sometimes it doesn't do such a good job at all, and I
13 think that gets back to some of the questions that were over
14 here.
15 Now, that -- nobody should be too alarmed by that,
16 that's, in fact, expected, since the way that RTNDT is
17 defined in ASME NB2331 is it's designed to be a bounding
18 estimate of the transition temperature, so it's always
19 supposed to put the K1C curve here with what some people
20 have called white space in between.
21 Unfortunately, that's inconsistent with a PRA
22 approach that is premised on having best estimates of all
23 these parameters.
24 So, if we're going to stay consistent with the PRA
25 best estimate philosophy, we then need to make a bias --

1 make a statistical bias correction on that RTNDT value.
2 Now, this is something that we're -- I'll just
3 have to say we're still working out the details on, and some
4 of the candidate bias corrections are shown up here.
5 The mean values tend to be different, but in
6 answer to one of the questions that was asked of how far off
7 can RTNDT be, it can be anywhere from right on the money to
8 150 degrees Fahrenheit off, and that simply comes from -- in
9 the simplest way of looking at one of these corrections, you
10 plot the linear elastic fracture toughness data that you
11 measure for a particular material, you position a K1C curve
12 based on sharpie and NTD tests, which are, of course,
13 completely independent of the fracture toughness tests, and
14 you see how far they're apart.
15 It can be anywhere from zero to 150 degrees
16 Fahrenheit, and what I learned from Mohammed and his
17 graduate students is it's probably best characterized by a
18 uniform distribution.
19 So, in the process, we go through the type of
20 calculations that the licensees would have to perform to
21 estimate an un-irradiated RTNDT.
22 You can go to another view-graph and do the type
23 of calculations the licensees would have to perform to get a
24 shift, and of course, in the code, since the Monte Carlo, we
25 do this many, many, many, many times, we go into this node,

1 we add this to this, and then we make a bias correction by
2 just -- this is a cumulative distribution function -- by
3 simulating a random number from zero to one, coming in and
4 picking off the bias correction for that run, and of course,
5 that happens a whole host of times.
6 You then get your estimate of RTNDT irradiated,
7 which helps you -- which indexes you into what vertical cut
8 you take through here, and then you get your vertical
9 uncertainty that we were talking about before.
10 Now, again, like I said, this is a status report
11 of work in progress.
12 We had a meeting at the University of Maryland
13 yesterday, and one of the things we realized, because both
14 Dr. Modarres, Dr. Natishan, and all the folks at Oak Ridge
15 are still working on this, is that, as we've noted, the data
16 says that there is an unmistakable bias in RTNDT that we
17 need to correct for.
18 That bias enters this calculation in two places.
19 One is in the estimate of RTNDT irradiated that
20 you make for a particular vessel, and that's shown,
21 appropriately, as being corrected for here, but obviously,
22 it's had an influence here, because you plotted all of your
23 fracture toughness data versus RTNDT.
24 We're still working on the details of how that
25 should best be corrected for, but suffice it to say we need

1 to correct for that bias in the data set in an appropriate
2 manner, because otherwise, the data set includes a perhaps
3 un-decipherable mix of both aleatory and epistemic
4 uncertainties.
5 What we'd like to do if we can get the -- if we
6 can work out the math and -- pay no attention to the graphs,
7 I don't really have anything to say about them, just to say
8 that we're working on different mathematical correction
9 procedures, but what we're aiming to get, of course, here is
10 take the -- is a methodology to take the epistemic
11 uncertainty in RTNDT out of this fracture toughness
12 distribution so that we can treat it as a pure aleatory,
13 which is where Mohammed -- which is how Mohammed and Nathan
14 have recommended dealing with the fracture toughness
15 distribution.
16 The concept is to get -- and this, conceptually,
17 should work. The details, I must admit, escape me a little
18 bit, but the idea is to get all of the epistemic
19 uncertainties into RTNDT, and when you look at the process,
20 you conclude that's, indeed, where they are, and then just
21 leave the aleatory uncertainties in the WIBLE distribution
22 of fracture toughness, which represents the inherent
23 material -- the inherent inhomogeneity of the material in
24 the transition temperature regime.
25 So, that is something that's being worked out as

1 we speak and probably will be a good topic for the next
2 meeting.
3 So, so far, we've completed the statistical
4 transition fracture toughness model, we've collected all the
5 linear elastic data that we could lay our hands on, and did
6 a truly empirical fit to it.
7 I'd say we're probably about 85 to 90 percent of
8 the way on developing our PRA uncertainty framework. We've
9 understood the process using the root cause diagram
10 approach, developed mathematical models of the process, and
11 we're working on the details of the FAVOR implementation,
12 and of course, everything's an iterative process, and in the
13 process of getting this actually coded into FAVOR, we
14 realized that we had treated the model uncertainty in RTNDT
15 in the vessel estimate part but not in the toughness
16 correlation part. So, that's something we had to go back
17 and do.
18 Ongoing is full implementation into FAVOR, and as
19 I mentioned here, resolution of RTNDT bias correction
20 function and modeling procedure, and of course, assembly of
21 input data from the various plants that we're considering to
22 actually run these models.
23 Questions?
24 DR. POWERS: I didn't get to see why my WIBLE
25 distribution is of fundamental significance, but I guess

1 I'll have to wait on that.

2 DR. KIRK: I'd be happy to talk about that next

3 time, but I don't have my slides.

4 But I do want to point out, what we've focused on

5 here is a lot of the empiricisms behind this, but what also

6 stands behind all of the data that you see is really quite a

7 good fundamental understanding of why all the variations of

8 toughness with temperature should be the same before and

9 after irradiation for all these product forms, for all these

10 chemistries, and why all of the distributions should be the

11 same, and that's sort of part of the background basis, so we

12 can -- you know, we can brief you on that next time.

13 DR. WALLIS: I guess what will be interesting in

14 the end is how the results you're going to use for making

15 decisions are sensitive to the various things you did to get

16 those results.

17 Now, when you've got that far, you could see how

18 the assumptions and processes and all that influence the

19 actual final product.

20 DR. KIRK: Right.

21 DR. POWERS: Are there any other questions that

22 people want to ask?

23 DR. LEITCH: Could you say a word about how you

24 separate out the epistemic influences from the aleatory?

25 DR. KIRK: Well, when you -- I'm going to go to a

1 completely different talk, because it's color-coded better.
2 DR. POWERS: I think, in view of our timing, maybe
3 we should leave that for another -- alternate presentation
4 or off-line.
5 DR. KIRK: Okay.
6 DR. POWERS: Okay.
7 Well, thank you very much.
8 I will recess this now for 15 minutes, and then we
9 will come back and discuss our report on the nuclear plant
10 risk studies, and we can dispense with the transcription at
11 this point.
12 [Whereupon, at 3:35 p.m., the meeting was
13 concluded.]
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REPORTER'S CERTIFICATE

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

NAME OF PROCEEDING: 476TH ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLACE OF PROCEEDING: 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.

Mike Paulus

Mike Paulus
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