

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

**Title: BRIEFING ON IPE PROGRAM AND SEVERE
ACCIDENT RESEARCH PROGRAM - PUBLIC
MEETING**

Location: Rockville, Maryland

Date: Wednesday, April 19, 1995

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1 UNITED STATES OF AMERICA
2 NUCLEAR REGULATORY COMMISSION

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4 BRIEFING ON IPE PROGRAM AND SEVERE
5 ACCIDENT RESEARCH PROGRAM

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7 PUBLIC MEETING

8
9 U.S. Nuclear Regulatory Commission
10 One White Flint North
11 Rockville, Maryland
12

13 Wednesday, April 19, 1995
14

15 The Commission met in open session, pursuant to
16 notice, at 10:00 a.m., Ivan Selin, Chairman, presiding.
17

18 COMMISSIONERS PRESENT:

19 IVAN SELIN, Chairman of the Commission
20 KENNETH C. ROGERS, Commissioner
21 E. GAIL de PLANQUE, Commissioner
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1 STAFF SEATED AT THE COMMISSION TABLE:

2 JOHN HOYLE, Secretary of the Commission

3 KAREN CYR, General Counsel

4 JAMES MILHOAN, Deputy Executive Director for NRR,
5 Regions and RES

6 THEMIS SPEIS, Deputy Director, Office of Nuclear
7 Regulatory Research

8 JOSEPH MURPHY, Special Assistant, RES

9 ASHOK THADANI, Associate Director for Inspection
10 and Technical Assessment, NRR

11 MARY DROUIN, IPE/IPEEE Section Leader, RES

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P R O C E E D I N G S

[10:00 a.m.]

CHAIRMAN SELIN: Good morning, ladies and gentlemen.

In a number of the sessions in recent weeks we've discussed the program to review the individual plant evaluations and the external events action part of the evaluations. We'll go into this in somewhat more detail today.

Actually, I do have two remarks. The first is that in the IPE area specifically I hope on behalf of the Commission that we get to have an understanding, both a substantive understanding of what kind of things have turned up in the plant evaluations and then a broader philosophical understanding of where do we go from here. This has been a very exploratory program. We've entered into it somewhat tentatively because there was a general feeling that plant vulnerabilities should be examined quite carefully, but we don't know or didn't know when we started exactly what to expect.

So, the first is substantively what kind of things have been turning up, but the second and of equal importance is now that we've gone through the process at least once, where do we go from here? Do we declare victory and say that's where we stand and we found out this is a topic that

1 should be explored carefully over the next several months
2 about follow-on work, what are the staff's feelings on that
3 issue?

4 The second question is that we have a -- the
5 second issue, the IPE is to examine vulnerabilities that are
6 essentially beyond the design basis. In other words, severe
7 accident -- potentials for severe accidents. Well, we have
8 an extensive research program and the protagonists of that
9 program unfortunately not all of them will be with the NRC
10 indefinitely. Particularly I'd like to recognize Dr. Speis'
11 contribution in this area. So, we would like to segue into
12 this severe accident research program somewhat beyond the
13 IPE area, just have a kind of a -- you can't go once over
14 lightly on severe accidents, but an overview of where that
15 program stands while we still have the benefit of being able
16 to draw on your experience as a member of the agency.

17 So, we will combine two programs which have a
18 connection, but it's not exactly one subject that we have
19 today. We have the two. In this context, we'll do two
20 things. One is we'll run the briefing until noon instead of
21 11:30 and the second is I will now stop talking.

22 Commissioner Rogers?

23 Commissioner de Planque?

24 Mr. Milhoan?

25 MR. MILHOAN: Good morning, Mr. Chairman and

1 Commissioners.

2 Joining me at the table today to discuss these
3 important subjects is Dr. Speis, as you've noted, Joe Murphy
4 and Mary Drouin from the Office of Research and Ashok
5 Thadani from NRR.

6 We'll attempt today to answer your questions as we
7 go through the briefing.

8 The staff today will discuss the status of the IPE
9 program and the results of our review so far emphasizing
10 generic and plant specific insights which the staff has
11 identified from our initial reviews. I want to add here
12 that we are looking at the information, the submittals for
13 insights which will be utilized for the staff as we proceed
14 down the path of more risk utilization in our regulatory and
15 licensing activities.

16 Dr. Speis will discuss the program status, the
17 results obtained to date and Ashok will follow with a
18 discussion of the utilization of results and specifically
19 how the IPEs fit into our present and future plans for risk-
20 based regulation.

21 Following the IPE presentation and discussion, Dr.
22 Spies will summarize some of the more important ongoing
23 activities in severe accident research area. As you've
24 noted, I think, in your briefing slides, we have a large
25 number of topics to discuss today, so I think we'll go ahead

1 and proceed and may have to assess near the end where we
2 stand as we go through the slides.

3 I'll ask Dr. Speis to go ahead and proceed.

4 DR. SPEIS: Thank you, Mr. Chairman,
5 Commissioners. I appreciate your kind words about my
6 involvement in some of these activities in the past.

7 The next viewgraph shows the outline of the
8 presentation.

9 [Slide.]

10 DR. SPEIS: Basically we will briefly touch on the
11 goals of the IPE program and how do we feel about whether
12 they have been accomplished. That's very important.

13 Then go to the IPE results. Slide number 2,
14 please.

15 [Slide.]

16 DR. SPEIS: Go the IPE results. Discuss plant
17 improvements and vulnerabilities identified by the licensees
18 and what they have done with them. Then go into a
19 discussion of insights that we are beginning to gain from
20 the program. Start with generic insights, address -- start
21 with the more global parameters like core damage frequency,
22 then going to accident sequences. Then look carefully at
23 what the results are relating to the conditional failure
24 probabilities of containment. You know, given a severe
25 accident, how does the containment response and what's more

1 important the various type of containments. That's a very
2 important issue.

3 Then address the variability in the IPE results
4 and later on touch to some extent how the results so far
5 compare with the safety goal. That is not a direct
6 comparison because, as you know, the IPE was not a level 3
7 PRA. But we're able to make some indirect comparisons.

8 Then discuss the statutes and the schedule of
9 where we go from here and Mr. Thadani will take over and say
10 more about future plans, where do you go from here, the
11 question that you raised, Mr. Chairman. It's very
12 important. He will focus on the utilization of the IPE
13 results in sites in risk-based regulation.

14 One issue that we should start addressing
15 carefully is how can we start standardizing some of those
16 things that we're gaining so people can use them. That has
17 to be a very slow and evolutionary process. But there are
18 things that we already have gained that we should start
19 putting them down for people to start looking at them.

20 As Mr. Milhoan said, if there's time we'll discuss
21 the severe accident research program.

22 [Slide.]

23 DR. SPEIS: The next viewgraph again briefly
24 summarizes the key elements of the IPE program. I don't
25 want to repeat some of the things that are in the Generic

1 Letter 1820, but one of the more important things was to
2 make sure that every plant understood what the severe
3 accident is and whether there were any vulnerabilities that
4 could be identified via this examination process.

5 Following the completion of our reviews, the staff
6 issues a report to each licensee on each individual IPE and
7 IPEEE based again on the submittal review. I would like to
8 point out that our review really has been kind of a -- you
9 know, the scope has not been as broad as in our previous PRA
10 reviews. It's kind of an audit and we focus basically on
11 whether the intent of the generic letter has been met. Even
12 though if we find something unusual, then we go into a more
13 detailed review and we have performed five of those. In
14 association with those five reviews, we have visited five
15 plants only.

16 The third item that is very important for the
17 farther utilization of PRA in this agency is to document the
18 significant safety insights from this examination. We plan
19 to issue a number of reports in this area. I will give you
20 more information, what should be the content of those
21 reports so they can be as useful as possible.

22 [Slide.]

23 DR. SPEIS: The next viewgraph summarizes our
24 belief that the IPE, the goals of the generic letter have
25 been achieved. I think it's the consensus of the staff here

1 that the utilities have met the goal, are meeting the goal
2 of the generic letter basically. They have developed in-
3 house staff PRA capabilities. In the old days, when a
4 utility wanted to do a PRA, they would hire a contractor and
5 the contractor will go into the plant and do the PRA and
6 then later on, I guess, the technical organization would put
7 into a shelf there. One of the things that we were
8 discussing during the development of the IPE program that it
9 was important for the staff to participate, the technical
10 people there so they can understand and digest insights
11 because that's what the essence of the program was.

12 All utilities have opted to do a level 1 and to
13 some extent a level 2 PRA. The generic letter gave them the
14 option of either doing a complete PRA or doing a kind of a
15 more simplified so-called heat core methodology. But all of
16 them have opted to do a level 1 PRA.

17 Generally, most of the plants, and I guess I don't
18 have the precise number, have indicated their intention of
19 maintaining and updating this IPE into a living PRA format,
20 updating them in terms of data, in terms of precursor
21 information and other relevant things. I can also say that
22 based on our reviews that all plants to a varying extent
23 have identified some improvements and four or five plans
24 have identified some important vulnerabilities. They were
25 so important that they were fixed immediately basically.

1 CHAIRMAN SELIN: I have a number of questions to
2 ask --

3 DR. SPEIS: Yes.

4 CHAIRMAN SELIN: -- on this slide because from
5 here you go into the specifics.

6 DR. SPEIS: Yes.

7 CHAIRMAN SELIN: Number one is, this was a generic
8 letter which is essentially a voluntary program.

9 DR. SPEIS: Yes.

10 CHAIRMAN SELIN: Is that correct?

11 COMMISSIONER ROGERS: Yes.

12 CHAIRMAN SELIN: The second is that we didn't
13 really give people a whole lot of guidance so that there's
14 no reason to expect these to be uniform from plant to plant.
15 I mean the focus was that the people should get to
16 understand their own plant rather than to generate some
17 generic information for us that would give us an oversight.
18 So, one would expect that we're going to do more with this.
19 We would then have to go back and give some guidance so that
20 you could go from one plant to another and have some
21 comparability.

22 DR. SPEIS: Yes, that's right.

23 CHAIRMAN SELIN: Is that correct?

24 DR. SPEIS: Absolutely right.

25 CHAIRMAN SELIN: Okay. The third is that we

1 didn't really review these IPEs. I mean in the sense that
2 we're not in a position to get up and say, "These are
3 right," or "These are wrong." We've sort of gone through
4 them to see if they make sense and to get some understanding
5 ourselves. But the fact that we've approved them -- I mean
6 reviewed them doesn't carry a lot of weight, does it?

7 DR. SPEIS: Well, we use words to that effect in
8 the letter that goes back to the licensees. We perform a
9 general review to see whether the intent, but we cannot
10 vouch for the specifics, whether some doubts are correct or
11 not correct or whether the specific model that you utilize
12 is the perfect model.

13 CHAIRMAN SELIN: Obviously we're looking for
14 both -- to help the licensees we're looking for strange
15 things so we can go back and say, "Based on our experience,
16 this looks sort of strange."

17 DR. SPEIS: Yes.

18 CHAIRMAN SELIN: And we're also looking to learn
19 things ourselves.

20 DR. SPEIS: Exactly.

21 CHAIRMAN SELIN: But the fact that the staff has
22 gone through an IPE doesn't put much weight on beyond what
23 the licensee has done in the IPE.

24 DR. SPEIS: I think you are about right.

25 CHAIRMAN SELIN: The reason I'm getting to that is

1 that we talk about maintaining a living PRA but these aren't
2 really PRAs in our sense. I mean they're a first cut at
3 them, but we can't vouch for them, we can't at this point
4 take an IPE and say, "Well, you folks don't have to work
5 very hard on your diesels because they turned out."

6 DR. SPEIS: Excuse me. On the other hand, they
7 did perform a PRA. It is a PRA and in some cases a very
8 good PRA, except we didn't review it in detail and Ashok
9 later on will discuss this issue in some detail.

10 MR. MILHOAN: Because it's important when they
11 come in to NRR to use the PRAs for licensing.

12 MR. THADANI: Maybe I will also comment at this
13 point perhaps.

14 CHAIRMAN SELIN: Please.

15 MR. THADANI: I think the staff review focus was
16 back to what was the goal of 88-20 generic letter which was
17 really twofold. Number one, that we encouraged the
18 licensees to participate in the conduct of these studies
19 because we thought you learn a great deal by just being a
20 part of that. So, did they participate in the conduct of
21 the IPEs was number one.

22 Number two is are there some significant outliers
23 as a result of our looking at it. So, the focus of the
24 review was not necessarily to look at what I would say to
25 really dig deep into the quality of the study, but enough to

1 say did they identify something that might be significant.
2 That is, the key was to look for outlier plants.

3 CHAIRMAN SELIN: Okay.

4 MR. THADANI: So, the depth of review is, I would
5 say, limited to that, fulfilling those objectives.

6 CHAIRMAN SELIN: But your phrase, I think, is
7 precisely right. Did they identify something significant?
8 We're not in a position to say that there were significant
9 things in these reviews that they didn't identify.

10 MR. THADANI: That's right. As it turned out in
11 many cases during the conduct of the studies they did
12 identify significant issues that took corrective action.
13 So, by the time they submit it, their IPEs, they --

14 CHAIRMAN SELIN: Let me tell you what I'm getting
15 at. I think this is a terrific program, but I don't want it
16 to be ratcheted up to the point where what was a voluntary
17 program because it made good common sense to look for severe
18 accidents and vulnerabilities turns out to be something that
19 claims more than it is, namely a basis for regulatory action
20 as if we had done an exhaustive review and could vouch for
21 the PRA --

22 MR. THADANI: I plan to address that issue in
23 particular.

24 CHAIRMAN SELIN: Okay. Fair enough.

25 COMMISSIONER ROGERS: Before we leave, I've got a

1 couple too.

2 I feel exactly the same way as the Chairman has
3 expressed. I think this has been a very, very useful
4 program and a very good thing to do. There were a lot of
5 discussion about whether we ought to do it at all or whether
6 everybody would participate and how hard would we lean on
7 people if they didn't participate. I think the fact that
8 we've got, I guess, 100 percent participation and very good
9 cooperation from the industry thus far on carrying out PRAs
10 for their plants is a really big step forward. I think that
11 we shouldn't in looking at the long-range possibilities fail
12 to recognize how big a step that was and I think a really
13 very big step to be able to get everybody aboard doing it,
14 yes, in their own way.

15 As you know, I'm concerned about standardization
16 and so on and so forth here. But the very fact that
17 everybody did it, it was a very big step forward, and to the
18 credit of everyone concerned, I think.

19 However, again as the Chairman has indicated, this
20 has been a voluntary effort. It hasn't had a high degree of
21 standardization. We haven't probed very deeply into each
22 one of these and those deficiencies are not so important for
23 the original purpose, but they could be very important on a
24 follow-on purpose. Namely, if we want to use this for risk-
25 based regulation, now that's another story.

1 MR. THADANI: I will share with you some examples.

2 COMMISSIONER ROGERS: But I do think that just
3 getting to this point has been very important and I think we
4 shouldn't lose sight of that as we can see what the
5 possibilities are down the road for the use of these
6 approaches.

7 But I have a couple of questions just on the
8 slide. Did you get some measure of in-house staff
9 capabilities in looking at how these were done? Undoubtedly
10 there were contractors involved to some extent. Could you
11 get some measure of what the distribution was of number that
12 were done entirely in-house, those that had some assistance
13 but really were pretty much on top of the process and those
14 that maybe we're not so sure how thoroughly the staff of a
15 particular plant actually got involved? Do you have some --

16 DR. SPEIS: Mary, would you like to address that?

17 COMMISSIONER ROGERS: -- table, a matrix of this?

18 MS. DROUIN: One of the things that we do look at
19 at the review is the level of participation by the licensee
20 and how much contractor help. In terms of the details of
21 thermal hydraulics running some of the more sophisticated
22 codes, they tended to rely on contractors. But when it gets
23 into the systems analysis and the accident sequence
24 delineation, the staff has pretty much done that work on
25 their own with guidance from contractors. The level of

1 degree, of course, has varied from licensee to licensee, but
2 I would say that at least 50 percent if not more than that
3 have done the bulk of the work themselves from what we've
4 seen.

5 COMMISSIONER ROGERS: Well, the matching to the
6 actual conditions in the plant, that's the thing that the
7 utility people themselves have to do. I mean they have
8 to --

9 MS. DROUIN: And we've seen that they use a lot of
10 --

11 COMMISSIONER ROGERS: -- know exactly what the
12 situation is in a particular part of the plant.

13 MS. DROUIN: And they've used a lot of in-house
14 peer reviews, getting the operators involved and the
15 maintenance staff involved in reviewing their data that
16 they've input. When I say data, I mean more than just the
17 mathematics of it, but looking at the information that
18 they've used and looking to see if the results seem
19 reasonable next to their design and operation.

20 COMMISSIONER ROGERS: This question of the living
21 PRA, I have a couple questions about that. One is are we
22 considering as included in the definition of a living PRA
23 the concept of a dynamical PRA? In other words, a living
24 PRA might be the best conditions of the plant and the PRA
25 that leads to that and then when you make a change in

1 something in the plant on a permanent basis you redo the PRA
2 and in that sense it's a living document, as distinct from
3 what I'd call a dynamic approach. Namely, well, when you're
4 taking certain systems out of service for maintenance and so
5 on and so forth, without making a fundamental change in the
6 plant design, that changes the PRA. That changes the bottom
7 line. And to what extent the dynamical aspects as
8 contrasted with the kind of updating that has to be included
9 in the usual interpretation of a living PRA.

10 MR. MILHOAN: I think we've got two different --
11 Themis, why don't you go ahead with the first one.

12 DR. SPEIS: Ashok, go ahead.

13 MR. THADANI: We've been -- actually both issues,
14 we've been conducting some dialogue with NEI and they have a
15 working group focusing attention on just these types of
16 issues. In terms of living PRA, they have developed some
17 thoughts and guidance on what frequency one should consider
18 when modifications were made to the plant, et cetera, for
19 updating the PRA.

20 As far as the dynamic effects, it's driven largely
21 by licensee applications and what we're seeing is increasing
22 interest on the part of the licensees to, in fact, make such
23 use of these PRAs. South Texas had come in for some
24 relaxation of some technical specifications which was driven
25 by their plans to conduct certain preventive maintenance at

1 power. Again, the idea of configuration became very
2 significant and that's a dynamic aspect. So, they had to go
3 back and modify the models actually in their PRA to be able
4 to do that and we reviewed and approved those changes.

5 I'd say there's some licensees moving in that
6 direction.

7 DR. SPEIS: Let me add something, Commissioner. I
8 think this is an important issue because sometimes we chase
9 minute things and yet if you plot the core damage frequency
10 versus time, there could be a week, for example, where some
11 important systems could be out of service and all of a
12 sudden the core damage frequency. So, that's an issue that
13 I think we have to look very careful and when you talk about
14 core risk based regulation, it's something that we really
15 have to understand very carefully before we blindly in a
16 global way provide --

17 MR. THADANI: For that application, and I will
18 show you a viewgraph, for that application you truly have to
19 have a very high quality study because you're globally using
20 it now.

21 COMMISSIONER ROGERS: Right.

22 MR. THADANI: So, you'll see it. It's at the
23 bottom of my list for a reason and that's the reason.

24 COMMISSIONER ROGERS: And then the other question
25 had to do with the extent to which there was consistency in

1 the use of data, generic data versus actual data for the
2 plant. There's some suggestion that licensees may have made
3 the choice to use generic data when that happened to look a
4 little bit better and actual performance data on their own
5 plants when that looked at little bit better. It seems to
6 me there is a question here that we have to pursue as we go
7 ahead. I think that may not be the big question right at
8 this point, but again it's involved in the follow-on. But
9 there I think we're going to have to try to see that there
10 is some standard way of approaching it. If there really is
11 data, actual performance data on equipment in the plant,
12 that should be used, not generic data that happens to be a
13 lot more favorable.

14 DR. SPEIS: Commissioner, in the generic letter we
15 encouraged them to use plant-specific data. We understand
16 that most of them have used a combination of data. Okay?

17 COMMISSIONER ROGERS: Yes.

18 DR. SPEIS: In fact, let me say right now that one
19 of our contractors sent us a letter raising a number of
20 questions and that was one of them. I don't think, unless
21 you gentleman, you Commissioners, I'm sorry, would like us
22 to go into the substance of it, but what we plan to do,
23 we're going to treat it like a DPV. It's a different
24 professional view and plan to have a panel made up of
25 members from our office, NRR and AEOD to look very carefully

1 into the substance of the concerns that the gentleman
2 raised.

3 COMMISSIONER ROGERS: I'm glad to hear that. I
4 have read that letter and I think --

5 DR. SPEIS: I have personally read it and I have
6 my views, but I don't want to prejudice --

7 COMMISSIONER ROGERS: It's something that needs to
8 be thought through very carefully.

9 DR. SPEIS: Very carefully and we plan to do that.
10 As soon as this meeting is over, we'll probably get
11 together. But you'll be informed of the results of the
12 review and the basis and overall to get him involved also in
13 this process.

14 COMMISSIONER ROGERS: Very good. Thank you.

15 DR. SPEIS: I would like to remind also all of us
16 that even though it was voluntary, and I guess sometimes the
17 lawyers have to tell us what is voluntary and what is not
18 voluntary, it was one of the goals, one of the things that
19 led to the closure of severe accident issues for existing
20 plants. You remember, after TMI the issue of severe
21 accidents for existing plants was all over the place. This
22 was one of the elements that we put together to lead to
23 that.

24 [Slide.]

25 DR. SPEIS: Okay. The next viewgraph will get

1 into the IPE Insights Program scope. As I say, we looked
2 carefully at the core damage frequency, containment
3 performance results. We look at the generic results, LWR.
4 We will take a look at the plant-specific results. We'll do
5 comparisons among and within various plant groups and then
6 do comparisons with the safety goal.

7 The heart of this always will be why, why is
8 something like that? Why is something different? Why is a
9 plant -- the station blackout contribution is 10 minus 5 and
10 another one is 10 minus 7? Is it because it has good
11 redundancy or diversity or the way something has been
12 implemented? These are the real insights, I guess. We have
13 to go always behind the numbers and I think we have a staff
14 here both in Research and in NRR and AEOD and the last ten
15 years of experience with contractors, we feel much more
16 confident about going beyond the numbers and addressing
17 those questions. These are the things that we'll try to
18 codify for you so when something comes in people will be
19 able to ask the right questions or use the information as
20 they are --

21 COMMISSIONER de PLANQUE: I understand all the
22 things that you would like to interpret from the results.
23 But in your examining the results, are you going to be able
24 to go back and look at the very kind of thing that
25 Commissioner Rogers was just mentioning, the type of data

1 that went into it? Was it generic data?

2 DR. SPEIS: That will be part of --

3 COMMISSIONER de PLANQUE: You will be doing that?

4 DR. SPEIS: That will be part of it. In fact, if
5 you recall, we sent you a memo back in January and we said
6 that one of the things that we want to do is start codifying
7 things and start addressing such topics as when is generic
8 data sufficient and when it is not sufficient. Maybe there
9 are some issues, some areas of generic data even though
10 they're broad enough, might be sufficient, but in other
11 cases they might not be sufficient. So, that's a very
12 important --

13 COMMISSIONER de PLANQUE: Because before you can
14 draw any kind of conclusions out of the results, you have to
15 know the validity of the result itself.

16 DR. SPEIS: We're very sensitive to that and Ashok
17 will say a little bit more about that.

18 Also, we're examining the improvements that they
19 have made and we're trying to see if there's a pattern
20 there, if something shows up in more than one plant or in a
21 class of plants. Also, how did they quantify these
22 improvements? These type of insights also will be very
23 useful to us in our regulatory analysis. When we do
24 regulatory analysis work, we always assess whether something
25 will improve risk or not improve risk, reduce risk. These

1 insights will be of extreme use to us.

2 The IPE information being collected will be
3 documented. Like we'll have a separate program that is
4 documenting all the information. You know, for example, the
5 safety systems, information from every plant, dependencies,
6 results, success criteria, all the relevant information that
7 is important for PRA application or for risk-based
8 regulation or even for system analysis or for other things
9 that NRR reviews on a daily basis where they have to take a
10 look at the system configuration. So, we'll have all that
11 computerized and that program has begun already.

12 COMMISSIONER de PLANQUE: I hate to keep pushing
13 this point. Before you go that far to look at plant to
14 plant differences of trends or what the results mean, will
15 you be validating the results for the individual plants?
16 Will you know the quality of what exists for each individual
17 plant?

18 MR. MURPHY: What we'll be doing is finding the
19 source of the variability. So, we'll be looking at it --

20 COMMISSIONER de PLANQUE: But are you doing that
21 by looking at the whole set of results or are you doing that
22 by looking at the individual plants?

23 MR. MURPHY: We'll be looking at the spread over
24 all the plants and when they're grouped tightly together we
25 won't look that carefully. Where there's a broad spread,

1 we'll look and see why the spread. That will take up
2 perhaps into seeing whether it's plant-specific that's doing
3 it versus generic, different modeling of a given component.
4 For instance, there are a lot of different models that have
5 been used in reactor coolant pump seals. That could cause a
6 difference in spread for some things and we'll be able to
7 identify what made something high and what made something
8 low, what would the source of -- not only that there's a
9 variability, but what the source of that variability is.

10 COMMISSIONER de PLANQUE: But you're going to use
11 the variability or the outliers or the trends in order to
12 try to ferret out those problems. Is that your approach?

13 MR. MURPHY: We'll be using the fact that there's
14 a wide spread from plant to plant to cause us to focus in to
15 look in that area to find out what the differences are.

16 COMMISSIONER de PLANQUE: The answer is yes. If
17 there were some bias that was introduced in the way these
18 things were done in most of the plants, then such an
19 evaluation may not discover that bias.

20 MR. MURPHY: That's true. What we hope to do --
21 now, we do a limited review, but our review is focused on
22 the boundary conditions and assumptions of the analysis with
23 a basic assumption that I don't think is too bad, that the
24 basic detail of the fault trees and event trees tend to be
25 done reasonably well. If you focus on the boundary

1 conditions and the assumptions and the basic models that are
2 used, you probably don't do too badly in coming up with a
3 feel for the goodness of the work that was done.

4 COMMISSIONER de PLANQUE: Well, the key could be
5 in those assumptions.

6 MR. MURPHY: Yes, to some extent we pick that up
7 in that. But yes, if there's a systematic bias across the
8 entire industry, looking at variability --

9 COMMISSIONER de PLANQUE: It's not going to pick
10 that up.

11 MR. MURPHY: -- would not do it unless we pick it
12 up in looking at the boundary conditions and assumptions.

13 DR. SPEIS: I think it's also fair to say that
14 most of the information is generic. Plants, as experience
15 is accumulated, are starting to develop their own data.
16 Initially we even used data from other industries like pump
17 behavior. Pump behavior is pump behavior as long as you
18 understand the pressures and the temperatures and maybe if
19 there are any radiation effects. But one still has to use
20 common sense to make sure that irrelevant and conditions
21 have been taken into account.

22 [Slide.]

23 DR. SPEIS: The next one, page 6, summarizes the
24 improvements, all plants identified improvements as a result
25 of IPE. Again, based on what we have reviewed, all these

1 improvements decreased the core damage frequency to some
2 extent. Some of them more than some others, some others
3 less.

4 Improvements mostly involve changes to operations
5 involving modifications to procedures and training and maybe
6 minor system changes, pipes or valves or some hoses or
7 things like that. Sometimes in the plants there are systems
8 that are not "safety related." In the old days, people
9 didn't know what to do. But now, with the advent of PRAs
10 and emergency operating procedures, they think carefully how
11 they can use those systems as backup to more safety grade
12 systems.

13 CHAIRMAN SELIN: Or conversely, where challenges
14 will arise even coming out from safety-related systems.

15 DR. SPEIS: Yes.

16 [Slide.]

17 DR. SPEIS: The next one, viewgraph, talks about
18 the vulnerabilities. Basically the licensees themselves
19 define what is meant by vulnerability. When the program was
20 developed, we had many ideas and arguments and discussions,
21 especially with ACRS, about vulnerability. So, we decided
22 let's leave it up to the plants. So you can see a list of
23 vulnerabilities that we have here, some of them, if the core
24 damage frequency was greater than 10 to the minus 4 per
25 reactor year, in other cases whether a sequence contributed

1 substantially to that core damage frequency.

2 I have listed some of the so-called
3 vulnerabilities that were identified by a number of plants
4 here. Surry, internal flood. In fact, when they made the
5 change, I think the core damage frequency was decreased even
6 more than one order of magnitude, within one and a half
7 order of magnitude or something like that.

8 COMMISSIONER ROGERS: Have you come to any view
9 yourself as to how to define vulnerabilities now? In other
10 words, having given everybody a shot at it and seeing how it
11 comes out when you look at this, could you then say, "Well,
12 we could wrap this up in a nice neat package in some way?"

13 DR. SPEIS: Well, I even looked at the dictionary,
14 Commissioner, and I found about four or five entries. You
15 know, like susceptible to damage. That's like at Surry
16 where the -- was it the --

17 MS. DROUIN: They had a leak in a circulating
18 water line.

19 DR. SPEIS: Yes. There was a leak in the -- which
20 room?

21 MS. DROUIN: There was a leak in the circulating
22 water line in the turbine building.

23 DR. SPEIS: In the turbine building. That could
24 take out many important systems, some of the electrical
25 systems. So, that's kind of an obvious vulnerability.

1 Also, if all of a sudden you find out that the
2 station blackout contributes 99 or 50 percent or more to
3 this, then you have to ask the question why. Is there
4 something with my diesels or is there some common cause
5 failure? It's a plant-specific thing, but something that
6 could be susceptible to core damage.

7 COMMISSIONER ROGERS: Well, I was interested to
8 see the instrument air system on there, at least for
9 Kiwanee. That's not a safety-related system. It's always
10 struck me as one that was extremely important and yet it's
11 never been one that's been on our list really.

12 DR. SPEIS: But when we were discussing the
13 maintenance rule in the reg. guide, we looked at systems
14 that are not safety grade but somehow could have an adverse
15 effect on safety systems. This is something that wasn't
16 looked at in the old days. The old days we were focusing
17 strictly on so-called safety grade systems.

18 COMMISSIONER ROGERS: Right. Right.

19 DR. SPEIS: We thought that they were perfect and
20 isolated, but somehow some line could touch them and affect
21 them. Okay.

22 [Slide.]

23 DR. SPEIS: The next slide, we're beginning to use
24 art. Page 8.

25 CHAIRMAN SELIN: Well, it's certainly not science,

1 Dr. Speis. This is the chart in your whole file that I had
2 the least confidence in of any one at all.

3 COMMISSIONER ROGERS: I thought it was a map of
4 New York City.

5 MR. MILHOAN: We try.

6 CHAIRMAN SELIN: No. But based on your opening
7 remarks, really this is the one in which we can have the
8 least confidence because we don't have any confidence in the
9 absolute values or the comparability from --

10 DR. SPEIS: But, Chairman, the Y is the thing that
11 we have to see. Y is the -- you know, for example, the
12 PWRs, the 17 PWRs, the core melt frequency between minus 4
13 and minus 5 times 10 to the minus 4. Why is the same BWR on
14 the extreme left closer to 10 minus 6?

15 CHAIRMAN SELIN: But we didn't take any steps in
16 setting this up to have any confidence in the comparability
17 from plant to plant.

18 MR. MILHOAN: No, we didn't.

19 DR. SPEIS: Let me give you some -- for example,
20 we have looked at the one -- we haven't, you're absolutely
21 right. But this plan here showing on the left -- this is
22 right, this is left -- two BWRs where the core melt
23 frequency is closer to 10 minus 6. They use as optimistic
24 values as possible.

25 CHAIRMAN SELIN: Right.

1 DR. SPEIS: The most optimistic success criteria.
2 Some others use success criteria that possibly came from the
3 FSAR. Some were in between. Even though we know if you do
4 detailed analysis sometimes you don't need two pumps or
5 three pumps which are part of the design basis, but one pump
6 will do. But I think that the ones on the extreme left use
7 as realistic or optimistic. I don't want to use the word
8 "realistic."

9 I'm sorry I interrupted you.

10 CHAIRMAN SELIN: No, no, no, no. That's not the
11 point. The point I'm making is when we put up a chart with
12 an NRC seal on it, it's very misleading. I remember we were
13 briefed on Fitzpatrick at the time they were going through
14 some of the worst problems and they had infinitesimal risk
15 probabilities. We just haven't done anything to have any
16 confidence that a chart like this, other than as a simple
17 array of what people claim, has any value. I really want to
18 downplay the value of a chart like this.

19 MR. THADANI: If I may comment, I personally
20 certainly agree with your view that one has to be very
21 careful in terms of the bottom line estimates out of IPEs,
22 but I think the real value -- well, at least qualitatively I
23 think there's useful information here. What it says is you
24 would expect boiling water reactors to have lower core
25 damage frequency than pressurized water reactors. I think

1 you can probably substantiate that by understanding of how
2 boiling water reactors operate and the kinds of systems that
3 they have.

4 CHAIRMAN SELIN: But you had that coming into
5 this.

6 MR. THADANI: I agree. I agree.

7 CHAIRMAN SELIN: Number one, it's probably
8 reasonable to expect that qualitatively the licensees have
9 figured out sort of within their plants which sequences and
10 systems are larger contributors than others maybe. That's
11 the easiest thing to do. The second is they may even have
12 figured out in some kind of absolute terms not only which
13 are the large contributors but which of them are worrisome.
14 But then those are two things that we could presumably get
15 out of our reviews because we do assume enough to take a
16 look and see if there's some kind of internal consistency
17 and we looked at the outliers. But to actually put down a
18 number on an NRC chart implies a level of review that's
19 three levels deeper than you've claimed to have done and
20 that's why I'm --

21 MR. MILHOAN: We totally agree.

22 DR. SPEIS: This is their numbers.

23 CHAIRMAN SELIN: To go back to what I said to the
24 Towes Perum people, this is what they say their numbers are
25 and that's all it is.

1 MR. MILHOAN: That's exactly correct.

2 CHAIRMAN SELIN: We don't know if these are within
3 a factor of 100 right or internally consistent.

4 MR. MILHOAN: That's entirely correct.

5 DR. SPEIS: But again the insights, the whys,
6 because we care about the reliability of systems, the safety
7 systems so they can function when they are called upon, and
8 I think we can get some insights from this type, even though
9 they're all over the place.

10 [Slide.]

11 DR. SPEIS: The next viewgraph shows the relative
12 contribution of the dominant accident sequences. On the
13 average, as you can see, station blackout, transients and
14 LOCA still tend to dominate the contributions from both BWRs
15 and PWRs. One of the things that we're going to take a
16 closer look is what contribution the station blackout rule
17 made in reducing the contribution of the station blackout.
18 We'll have a special study looking into that.

19 CHAIRMAN SELIN: Here's a question that's
20 embarrassing four years into it, but why your ATWS is not a
21 significant contributor to PWRs.

22 DR. SPEIS: It's mostly a --

23 CHAIRMAN SELIN: Control rods drop more easily
24 than they go up or is it something more complicated?

25 MR. THADANI: ATWS is not a significant

1 contributor in PWRs for basically two reasons. The first
2 reason is the inherent designs are much better able to cope
3 with failure to scram. The second part is that the real
4 risky period in terms of ATWS for pressurized water reactors
5 is a very short time period when the temperature coefficient
6 is not negative. Because of that, the risk of ATWS for PWRs
7 is much lower. I mean the consequences of that event are
8 lower for the PWRs in general than for BWRs.

9 CHAIRMAN SELIN: Are there any surprises on this
10 chart from what you expected?

11 [Slide.]

12 DR. SPEIS: The next viewgraph shows the large
13 variability among the individual plants. This one shows for
14 BWRs. The large variability among individual plants from
15 the different contributors. For example, you see transients
16 in BWRs. They range over a three and a half orders of
17 magnitude.

18 As Joe said, Dr. Murphy said, we have to look at
19 at least some of the end points, some of the less risky and
20 the more risky ones and see why. For example, look at the
21 SBO, the first one, the station blackout, the station
22 blackout sequence. The mean is roughly 7 times 10 to the
23 minus 6 which is a little bit better than the goal that we
24 had set for the station blackout rule. But there are some
25 plants that the contribution is 1 times 10 to the minus 7.

1 We looked at that and we found out that this plant has four
2 redundant and independent diesel generators. Okay? So
3 there is an answer for some of these things.

4 CHAIRMAN SELIN: I've been going on the assumption
5 that if an analysis is optimistic, it's optimistic across
6 the board. But actually there's no reason to assume that.
7 Have you found that those plants that have come in with very
8 low risk probabilities, in other words that use optimistic
9 results use them in all the systems or have you found
10 variability with particular plants where they electricity
11 guys might have been optimistic but the LOCA folks were more
12 conservative?

13 DR. SPEIS: Yes, go ahead.

14 MS. DROUIN: We have seen some plants where what
15 your expectation was was met, where they were optimistic on
16 their success criteria, on their data, on their human
17 reliability. But we have also seen the opposite where
18 they're only optimistic in one area. For example, on their
19 human error they've been very optimistic but maybe on their
20 success criteria they might have used FSAR. So, it's been
21 very much of a mixture is what we've seen. It hasn't been
22 uniform. If they're optimistic, they aren't necessarily
23 optimistic in every element.

24 CHAIRMAN SELIN: What you've cited is interesting,
25 but it's more functional. In other words, one element

1 across the board versus another one across the board, which
2 is a very interesting answer. What I was trying to get at
3 is sort of a simpler thing. Can we have confidence that if
4 a plant says that station blackout is twice as important as
5 LOCA that, in fact, that's right? In other words, that they
6 did the station blackout and the LOCA analysis in comparable
7 fashion or could one have been --

8 MR. MILHOAN: Within an individual IPE.

9 CHAIRMAN SELIN: Within an individual IPE.

10 DR. SPEIS: Joe, did you want to say something?

11 MR. MURPHY: I think it varies and the thing about
12 station blackout, some of the plants have taken credit for
13 the corrections they've made for the station blackout rule.
14 Some of them were done early enough. When you do a PRA you
15 pick a date in which you freeze the design. Sometimes they
16 froze that design before they made the fixes associated with
17 the station blackout rule. But some of the variability you
18 see there, for instance, is a point of time. There may be
19 further changes to the station blackout rule that were
20 coming.

21 MR. MILHOAN: I don't think we have the answer to
22 your question, Mr. Chairman.

23 DR. SPEIS: No. It's a question of internal
24 consistency and we should take note of that and make sure
25 that --

1 CHAIRMAN SELIN: I mean if we think we can draw
2 conclusions not on the absolute risk numbers but on the
3 relative values on the sequences, then we need to be able to
4 answer it if we had a question.

5 DR. SPEIS: Supposedly every PRA has an audit
6 committee that look for consistency.

7 CHAIRMAN SELIN: I see.

8 DR. SPEIS: So, hopefully, but I don't think we
9 can say absolutely.

10 [Slide.]

11 DR. SPEIS: Page 11 indicates the same type of
12 variability for PWRs. In some cases, the variability is not
13 as wide as in BWRs.

14 I would like to go to the next viewgraph which I
15 tried to explain it, first of all. Page 12.

16 [Slide.]

17 DR. SPEIS: This is the human factor. This is the
18 area that was kind of all over the place, what type of human
19 errors was assumed. I have tried to indicate here a kind of
20 a simple system. In many plants there are still -- the
21 operator has to become involved himself. There's no
22 automatic way of realigning a system. He has to go there
23 and turn the knobs himself. If you have a LOCA, for
24 example, and the RWST empties into the sump, then the
25 operator at some point has to go and change, realign the

1 system to take water from the sump and back into the core.

2 You can see here that for this type of event, the
3 variability of the human error is all over the place. We're
4 really surprised that it is such a wide range. So, we're
5 going to have to go and look at this very carefully to see
6 is there a deterministic relationship.

7 For example, it's possible that in some plants
8 there isn't enough time so therefore the operator error
9 could be higher or, you know, the procedures are such
10 that -- but this is the type of thing that we're going to
11 have to come to grips because the human element is an
12 important contribution in running a plant, not only from a
13 management standpoint but in doing some of these individual
14 operations that are still very important in responding to
15 accidents or transients, so that's the reason that we
16 indicated this slide to see --

17 COMMISSIONER ROGERS: This human error
18 probability, these are what they assumed and took in doing
19 their analysis? Is that it? I mean, these are assumed
20 numbers?

21 DR. SPEIS: This is conditional to the event.
22 Given a LOCA or given a transient which leads to a LOCA and
23 eventually when the operator has to go down there and make
24 the switch from the injection into the circulation, this is
25 the error that was assumed and we want to find why. What is

1 the reason for it? Is it the timing or some other things
2 that are not obvious to us? Because, when all of us talk
3 about risk-based regulation, you know, somebody will come in
4 with a proposal or submittal and he will have a low error or
5 a high error and then we will have to decide whether it
6 makes sense or it's important enough that it has an effect
7 on what he is proposing to do.

8 COMMISSIONER ROGERS: And there's no entries for
9 the CE plants because they can't do that? Is that it? They
10 can't go to manual recirc?

11 DR. SPEIS: Well, let's see. We don't have CE
12 plants here. We have two loops, you know, we don't --

13 COMMISSIONER ROGERS: There's nothing for CE
14 plants.

15 MS. DROUIN: They're only plants with manual.

16 DR. SPEIS: The remaining of the plants have
17 automatic and for this example we use the plants that have
18 manual recirculation.

19 COMMISSIONER ROGERS: So the CE plants can't go to
20 manual?

21 DR. SPEIS: These are all the plants that have
22 manual, yes.

23 MS. DROUIN: They can go manual, but we only
24 looked -- for this chart, we only took the failure to go to
25 recirc for those plants that didn't have an automatic.

1 DR. SPEIS: They still have a manual --

2 MS. DROUIN: I mean, if the automatic fails you
3 can still manually do it, but that data is not plotted here.
4 These are for the plants that don't have the automatic
5 capability.

6 [Slide.]

7 DR. SPEIS: The next viewgraph is very important.
8 These numbers tell us a lot, even though some numbers don't
9 make sense to some of us who know a little bit about this.

10 Here we have left the likelihood of the accidents
11 and we are going into containment performance given an
12 accident. How does the containment respond? What are the
13 type of failures? And so these are conditional to the core
14 degradation and vessel failure or core-in-the-floor as some
15 people used to call it.

16 So there are some things. For example, for large
17 drys it's approximately what we would have expected, or even
18 for subatmospherics, from our general knowledge from NUREG
19 1150 and from many other PRAs that we have reviewed and from
20 our understanding of the challenges to containment given a
21 severe accident.

22 Under the ice condenser, for example, you see here
23 early containment failure the number is .02 and we don't
24 understand this because unless for those ice condensers the
25 contribution of station blackout is zero -- but we don't

1 think that's the case because if station blackout is still
2 important they will take the igniters out, okay, and the
3 igniters are there to burn the hydrogen in a controlled
4 manner and if you lose the igniters you start accumulating
5 hydrogen and you could fail early. So this .02 is kind of
6 low and so it doesn't --

7 CHAIRMAN SELIN: Maybe they just assume they left
8 the doors open.

9 DR. SPEIS: So, again, you know, we have enough
10 knowledge in this area so that we have some confidence that
11 we should be able to find out why and ask the right
12 questions and be able to use those insights.

13 Look at the BWRs, for example. Early containment
14 failure there's a .22, 20 percent. We don't know, for
15 example, whether the Mark I issue, you know, where you could
16 fail the liner and lead to early containment failure is
17 considered here and whether they have considered procedures
18 which involves water. We have done a lot of work that
19 indicates that if you have availability of water to cool the
20 debris, you know, you reduce substantially the probability
21 of failing of the liner. So these are the type of things,
22 one of the things we haven't done yet in detail to see
23 whether the Mark Is have incorporated insights of the
24 research and other information that has been developed,
25 which has been widely agreed between us and the industry.

1 So, again, these are the type of things.

2 Also --

3 COMMISSIONER ROGERS: I take it you're comfortable
4 with the early containment failure for the subatmospheric?

5 DR. SPEIS: Yes.

6 COMMISSIONER ROGERS: Why is that so different?

7 DR. SPEIS: Why it's so low?

8 COMMISSIONER ROGERS: No, it's not so low. It's
9 the highest, early containment failure for subatmospheric
10 PWRs. Why is that so high?

11 DR. SPEIS: This .16?

12 COMMISSIONER ROGERS: Yes, compared to the other
13 PWRs.

14 DR. SPEIS: Well, some of them have lower pressure
15 capability and volume. We'll have to look into this one
16 here, because --

17 COMMISSIONER ROGERS: I mean, that stood out to
18 me.

19 DR. SPEIS: I'm not concerned as much as the .02,
20 so that's -- I was looking at that number. But we'll take a
21 look at the .16. It could be okay. And also, we don't know
22 how they treated some issues like direct containment
23 heating. That issue is not as important as we thought five
24 years ago, four years ago, and it's possible that some of
25 the utilities are not -- they haven't used all the latest

1 information, so that's another possibility that they haven't
2 carefully considered the latest technology in some of these
3 areas.

4 The next viewgraph we don't have to show because
5 it's really a summary of some of the things we've talked
6 about.

7 Let's go to page 15, because I want to make sure
8 there is time for Mr. Thadani to make his presentation.

9 [Slide.]

10 DR. SPEIS: Page 15 again summarizes the
11 variability in a number of areas, in application of methods,
12 assumptions, data, level of detail resolution.

13 Another thing that we find out is that I think we
14 need to address, if we are serious about risk-based
15 regulation, is to come up with a number of definitions that
16 are accepted across the board. For example, core damage
17 definition is one example that is all over the place. Some
18 utilities use the whether you just have exceeded the ECCS
19 criteria or some of them maybe go a little bit more into
20 clad oxidation, some other ones halfway between that and the
21 TMI accident.

22 And the other area is against a success criteria,
23 so it's another important area. Some people have used the
24 FSAR values, which is the design basis which we know it is
25 conservative. Some other ones have gone way into the

1 spectrum of optimism by doing detailed calculations which we
2 have not reviewed, and some of them are somewhere in-
3 between.

4 We already discussed the human error, which varies
5 widely.

6 Assumptions made in system and component
7 operability, for example, the effect of environmental
8 conditions has varied widely from our review so far.

9 The data, the use of generic versus plant specific
10 is an important issue. We urge them to use plant specific
11 data to the extent available. We know from our reviews that
12 a mixture of both were utilized and that's an area that all
13 three of you have raised and we have to look very carefully.

14 Level of detail is another important one, the
15 failure modes modeled, how detailed the fault trees were.

16 Another issue that could contribute some also is
17 the truncation values, at what point they truncated the
18 sequences.

19 And I have put the headline below, "Caution is
20 needed in the use of the IPE results in risk-based
21 regulation."

22 COMMISSIONER ROGERS: Well, it's probably more
23 than caution. I mean, you just need a system for doing it.

24 DR. SPEIS: It's not a very erudite statement.

25 COMMISSIONER ROGERS: But, I mean, I think that

1 the Chairman's question earlier, where do we go from here, I
2 think that's the important thing.

3 DR. SPEIS: That's right.

4 COMMISSIONER ROGERS: What is the program that we
5 should be considering now as we move ahead?

6 DR. SPEIS: I would like to summarize where we go
7 from here and give you my views at the end, but I would like
8 to --

9 CHAIRMAN SELIN: But before you get to that, I'd
10 like to correct what I hope is a misleading impression, I
11 mean, because we've got the Research briefing and actually
12 in the evaluations we ended up doing more from Research and
13 less from NRR than we had originally hoped, which I think is
14 a mistake.

15 We didn't give very good guidance. These are all
16 voluntary and we shouldn't spend so much time analyzing the
17 analyses. We know they're not going to be very comparable.
18 Whether they're different because they used different models
19 or different models, that's much less interesting. Much
20 more important is what did we learn about the plants, not
21 what did we learn about the process that we unleashed.

22 When you do your perspectives and your views and
23 where we go from here, my conclusion at this point is we may
24 have learned something useful about the plants but we didn't
25 learn a lot about the process because it wasn't much of a

1 process to begin with. I wouldn't like us to spend too much
2 time trying to figure out all the ways people did things
3 different other than to work with NEI on what happens on the
4 next wave, if there is a next wave.

5 Remember these are voluntary and rather than our
6 giving guidance on how to do an IPE, if they're going to
7 continue to be voluntary, we should be working with the
8 industry folks so that they might give some guidance as to
9 how to -- if they're going to be living PRAs.

10 What's most interesting to me is, number one, what
11 did we learn about individual plants or generic problems,
12 you know, station blackout as a problem. And the second is
13 it seems to me that rather than having contractors do a
14 whole lot of analyses and Research do the process we should
15 be getting our own people involved in these analyses. What
16 better way for our inspectors to know their own plants than
17 to have been through the detailed analyses that the
18 licensees have done of their own plants?

19 But I'd really like to focus on what did we learn
20 about Surrey and Indian Point 2 and FitzPatrick rather than
21 what did we learn about a process which was a pretty casual
22 process to begin with. And I understand that the briefing
23 is sort of slanted that way because we've put so much weight
24 on Research's analysis and not so much on NRR's.

25 DR. SPEIS: But, Mr. Chairman, I don't want to

1 argue with you --

2 CHAIRMAN SELIN: Sure you do. It's okay. That's
3 the idea.

4 DR. SPEIS: I think these are important things to
5 consider, but I think PRA still is an important tool and we
6 can start using it and we have been using it. I want to
7 make sure that by -- you know, some of the things that I
8 have in this slide are not that much different than 1150 or
9 some of the more robust PRAs that we have performed in the
10 past, but these are the things we have to be careful that we
11 focus on.

12 CHAIRMAN SELIN: I agree with you, but the real
13 question is what have we learned about plants by name more
14 than what have we learned about the state of the PRA art in
15 the licensees.

16 DR. SPEIS: We agree with you.

17 CHAIRMAN SELIN: We asked them a very vague
18 question for good reasons and we're going to get very
19 different answers. Now if we expect to get more comparable
20 answers, instead of spending a whole lot of time analyzing
21 the differences one would think about what kind of guidance
22 one wanted to give for the next wave, if there is a next
23 wave.

24 But the key thing is what have we learned about
25 our plants sort of one at a time and then by class. And

1 when you do write your lessons learned, I --

2 MR. MILHOAN: Yes, we need to focus on that area.

3 CHAIRMAN SELIN: -- hope there's more of that
4 than, you know, that if you ask a question without a lot of
5 guidance you're going to get very different interpretations
6 of what a proper answer is.

7 COMMISSIONER ROGERS: Well, I'm not disagreeing
8 with the Chairman, but I do think that what the staff is
9 telling us is how they were trying to come to that, I mean,
10 that this is the process in which they sifted the PRAs
11 through to try to pop up those things that they felt were
12 important to look at and I quite agree that when all is said
13 and done it's not the process itself that's important here.
14 What did you really learn about the plant? But to discover
15 that you have to have some idea of what the validity is of
16 the PRA that's popping that up for you, and so my
17 interpretation of what you've done here is this is kind of
18 the process that you've applied to assist you in getting to
19 the answer that we're really interested in, what really is
20 important at the individual plants.

21 CHAIRMAN SELIN: If you take a look at charts 8
22 and 9, I'm much more interested in how much confidence you
23 have in chart 9 than how much confidence you have in chart
24 8, so that's probably the easiest way to summarize.

25 DR. SPEIS: Well, basically on this one, Mr.

1 Chairman, on page 15, it kind of summarizes in words some of
2 the things there. I still think it's important that there
3 are some things that we can define, we can sit down and
4 define and we all accept and it would be obvious.

5 MR. MURPHY: I think one of the difficulties we're
6 having right now is that we're not through with analyzing
7 the insights and what you're seeing is a process where we're
8 using the variability of the target where we focused to find
9 out the reasons why.

10 There's interesting information we're putting
11 together now on a plant specific basis. For instance, I
12 found it very interesting just to look at listening to what
13 changes have been made to the plant as the -- during the IPE
14 process. Now we don't have a complete listing of that, but
15 I did a personal survey a while back just looking at our
16 staff evaluation reports where some of these things are
17 listed and you can see the extent to which the utility is
18 doing something.

19 I think we have a further goal ahead of us that
20 says that how we can use a PRA, whether it's an IPE or
21 something else, depends on, number one, the goodness of the
22 PRA, and, number two, the extent to which we have reviewed
23 it. And that varies for different applications, so in some
24 applications the IPE may be sufficient or sufficient with
25 minor fine tuning. In other cases, it may take a very

1 detailed review because subtle differences can make a big
2 difference and require a very high quality job.

3 Mr. Thadani referenced the configuration control
4 things. There's a significant amount of experience in the
5 UK where they are using such things on the Torness and
6 Heysham plants. I'd say they've had a very positive
7 experience with it, but to use it in the way they're talking
8 about requires a very high quality analysis, and the same
9 thing with optimization of tech specs and this sort of
10 thing. You can make what appears to be a very conservative
11 assumption in one area and derive other things very
12 nonconservatively, so conservative is a bad word when you
13 use some of these things because it depends on what you're
14 trying to effect. I think we're getting this out of the
15 analysis and what you're seeing now is we're about halfway
16 through and we're still in the process of gathering the
17 information that allows us to draw the insights and we're
18 not there yet.

19 MR. THADANI: I think, to follow-up on that, it's
20 going to be very, very difficult to be able to define what
21 is the so-called truly high quality PRA addressing not just
22 the issues of data but also consistency of assumptions,
23 models, and so on.

24 On the other hand, it seems to me that -- and the
25 cost of doing something like that to start now would be

1 pretty significant, I think.

2 What is more important is, I think, what the
3 Chairman said earlier, which is we should be stepping back
4 and working with the industry to see what kinds of
5 applications they have in mind. The process should be
6 driven by applications because it's going to be very tough
7 up front to say, "I'm going to start out with a fairly
8 perfect study." We need a lot of experience still through
9 those applications, look at what the end use is and then
10 look at the study to see -- specific focus on the study to
11 see does the study reasonably address what I'm trying to do
12 with the end us.

13 That's the process we need to go through and learn
14 from I think over some time period. That's not to say that
15 these studies cannot be used now. They can. There are many
16 places, in spite of some of the limitations they have, they
17 can be used for some decision. But we have to be careful
18 what are those decisions and the role of these studies in
19 those decisions.

20 I think we need some more time and we need to
21 learn ourselves, as well as the industry. We need to
22 learn --

23 CHAIRMAN SELIN: You know, what Dr. Murphy said I
24 thought was very well taken, that you're in the middle of
25 the street and you've got a bright street lamp at the

1 corner, so that's where you look even though you know you
2 lost the watch in the middle of the street. We haven't
3 finished the detailed analysis, so we're in a position to
4 talk about the methodology.

5 But you can make a number of conclusions. Number
6 one, these have been useful because plants themselves are
7 taking advantage of it.

8 MR. MILHOAN: Absolutely.

9 CHAIRMAN SELIN: And if nothing else happened, if
10 they never sent them to us, that's wonderful and that's
11 certainly enough to justify it.

12 On the other hand, unlike the earlier WASH studies
13 that showed some really scary things on Indian Point and
14 Zion, nothing has come out of this to give us the impression
15 that the plants overall individually and collectively are
16 well within safety goals and objectives.

17 MR. THADANI: I just would use a qualifier and the
18 qualifier is that while some licensee were conducting
19 studies, they found significant issues and corrected them.

20 CHAIRMAN SELIN: Sure, but nobody came in with a
21 number that scares us and we haven't been able to reproduce
22 these numbers and say they were off by a factor of 100.

23 The reason I make this point is we don't have a
24 regulatory basis for requiring that these studies be done at
25 this next level, be done. What we do have is some carrots

1 we can hold out which says that these are important, they're
2 useful, we hope you folks will keep these up yourself. And
3 if you think that overall we'll end up with a more efficient
4 regulatory basis by having PRAs that we both understand and
5 that we can both live with, we think we can simplify the
6 piece, but that's got to be voluntary because we don't have
7 a safety basis for requiring these at this point.

8 So, if it's going to be voluntary, then what we
9 need to do is take the kind of analysis Dr. Speis talked
10 about, but really put more of the burden on NEI to do this
11 and say, "If you want to come in and go -- you know, we
12 can't require you to do this. We hope you'll keep your PRAs
13 up to date because you'll end up with better plans, you'll
14 concentrate on where the problems are, you'll have safer and
15 cheaper plants."

16 But if we want to have a more efficient regulatory
17 basis which is built on these types of PRAs, we need more
18 uniform analyses. Not only higher quality, but more uniform
19 analyses, more standard analyses, than we have today. Then
20 it's sort of up to the industry to decide whether they just
21 want to live with the status quote, as inefficient as it is,
22 or they want to work cooperatively with us. But if they
23 want to do the second one, then there have to be industry
24 standards with which we concur on how to do an IPE and use
25 that as the basis for something which we certainly can't do

1 today, which is to put them in and say, "We can use your
2 numbers to, say, target our inspections or to decide which
3 rules make sense and which don't." We can't do that today
4 with these analyses or with our understanding.

5 MR. THADANI: I think you have described the
6 process perfectly, as a matter of fact, our interaction with
7 NEI and that industry is, in fact, very interested in going
8 forward and making use of these studies in a greater number
9 of areas and they are putting together their documents to
10 try and bring in some consistency and quality to these
11 studies.

12 CHAIRMAN SELIN: See, the reason I stress this
13 point is that -- there really are two points. One is the
14 voluntary basis for what we're doing and the second is how
15 little we really know about what they've done. The reason I
16 stress that is not as a criticism but really a support of
17 what we've done. We triggered a process which was useful to
18 the industry and which may eventually be useful to us, but
19 we don't have much of a stamp of approval to put on this and
20 I think we've got to stress this. That's why I keep
21 objecting to charts that show probabilities that say NRC in
22 the corner because all we're doing is tallying up their
23 analyses. We don't know if those numbers are right within a
24 factor of 100 and we have to make sure that people
25 understand we don't know those numbers, we don't claim to

1 know those numbers and therefore they can't act as if we've
2 accepted these numbers and go on from there.

3 MR. MILHOAN: You're entirely correct.

4 MR. THADANI: We fully agree with you.

5 CHAIRMAN SELIN: Dr. Speis?

6 DR. SPEIS: Yes. No. Can I continue?

7 CHAIRMAN SELIN: Please.

8 [Slide.]

9 DR. SPEIS: Page 16. I already talked about the
10 indirect comparison to safety goals. So, I can skip that
11 and go to slide 17.

12 By the way, in the insights report we'll hopefully
13 do a -- not hopefully, we'll do a more rigorous analysis
14 comparing with the safety goal because the Commission did
15 ask us that specifically.

16 [Slide.]

17 DR. SPEIS: On page 17, I will spend a half a
18 minute on the schedule of the IPE program.

19 We have issued 28 safety evaluation reports. All
20 remaining IPE reviews are in progress. We expect to
21 complete the bulk of our reviews, again the type of review
22 that we're doing, by the end of December '95 and our
23 estimated completion for the whole IPE program is the summer
24 of '96.

25 We plan to involve the resident inspectors

1 directly into the review process. Every time we complete a
2 review we have a meeting to go over the findings and the
3 insights and we'll be inviting the resident inspectors for
4 the plants that they are responsible for. I guess we should
5 have been doing that from the beginning.

6 CHAIRMAN SELIN: That's terrific because one of
7 the most useful things is for our inspectors, including
8 resident inspectors, to understand what the licensees think
9 are the vulnerabilities in their plant and something about
10 the --

11 DR. SPEIS: Especially now that these IPEs or
12 PRAs, they will find more use and the inspector will be more
13 involved. I guess we should have done it from the beginning
14 with mid-course correction.

15 We talked about the insights report and they will
16 plan to issue a series of reports. Maybe what will be
17 important is to -- some of them are on the way we have
18 outlined. So, we'll maybe work with others in addition to
19 NRR and AEOD to get some feedback what are the important
20 things that we want to focus on. Maybe we can get some
21 views from the outside world or --

22 MR. MILHOAN: I think so. I think that would be
23 very valuable.

24 DR. SPEIS: We got some good ideas today and maybe
25 we should --

1 COMMISSIONER ROGERS: Where does that prospective
2 on the impact of the station blackout rule report stand?

3 DR. SPEIS: Oh, it's delayed one month because NRR
4 wanted some additional things and we'll have it done in one
5 month.

6 COMMISSIONER ROGERS: So, it will be in there?

7 DR. SPEIS: Yes.

8 [Slide.]

9 DR. SPEIS: Okay. The next one talks about the
10 IPEEE program. It's a little bit behind. Not a little bit.
11 It's substantially behind the IPE. The estimated completion
12 date is the end of '98. We had a mid-course correction in
13 this area because we kind of changed the scope of the
14 program somehow, taking into account the resolution of the
15 issue of the hazard curve. You know, there are arguments
16 between EPRI --

17 COMMISSIONER ROGERS: Seismic.

18 DR. SPEIS: Seismic hazards between EPRI and
19 Lawrence Livermore and we had the National Academy involved.
20 We resolved that and as a result of that the scope of review
21 for a number of plants changed. So, we want to make sure
22 that that was taken into consideration and we have issued a
23 position for public comment addressing the new hazard curve
24 and the requirements as a result of it.

25 Another thing we're doing, we're carefully

1 integrating the Generic Issue A-46 which deals with seismic
2 response to the IPEEE, so we don't repeat things twice
3 basically.

4 So, with that, I complete the first part of my
5 presentation, Mr. Chairman and Commissioners, and I'll turn
6 it over to Mr. Thadani to --

7 CHAIRMAN SELIN: To answer all the questions.

8 MR. THADANI: Could we have the next viewgraph,
9 please?

10 [Slide.]

11 COMMISSIONER ROGERS: Well, he knows what they are
12 now.

13 MR. THADANI: Actually I think we have discussed
14 most of what I had intended to say. But briefly, Generic
15 Letter 88-20 reflected our thinking at the time. As Dr.
16 Speis said, the purpose of the program was that this was one
17 element in arriving at closure of the severe accident
18 issues. Thus, the focus simply was let's make sure we find
19 out if there's something big that we haven't recognized, big
20 in terms of its potential risk to public health and safety.

21 So, there was limited scope and the staff in the
22 generic letter, as a matter of fact, indicated some
23 simplified approaches would be acceptable and they did not
24 have to do a more expensive probabilistic risk assessment.
25 Fortunately, licensees went beyond what was said in the

1 generic letter and essentially all of them have done PRAs.
2 Most of them have actually done level 2 type of PRA studies.
3 So, to that extent, I think they've gone beyond what was the
4 intent of the generic letter.

5 But now we're in -- so, that was really what was
6 driving the staff's review focus also. But over the last
7 few years we've evolved to a certain extent and recognize
8 that we can make much greater use of these techniques in
9 some integral decision making process.

10 There are two parts, as I see it, of the work
11 that's been done so far still would be valuable to us as we
12 go forward. One is the reviews. Even though they are
13 limited, they have uncovered some inconsistencies and
14 limitations of these studies. I think that's very useful
15 information as we go forward.

16 Second part, and I'm a very strong supporter of
17 the insights work that's going on at Brookhaven National
18 Laboratory that Research has sponsored. I think that
19 program will also help us better understand variability and
20 data assumptions and so on. That is, at least it will point
21 out what some of the problems might be in terms of
22 inconsistencies of these analyses.

23 But that information alone does not still lead to
24 a view that says if you take care of this, you'll end up
25 with a high quality PRA. I think as I said earlier, the

1 real value is going to be to go through the lower part of
2 that chart. It's kind of hard to see, I think, for some
3 people. But the idea simply is as follows. Let's take a
4 look at specific applications that the industry is
5 interested in making PRAs. Let's look at the PRA at that
6 point and from all the lessons that we have learned take a
7 specific look at that part of the PRA to see how well that
8 part was handled. At that point, make a decision, is the
9 study itself good enough for that application or does it
10 need to be upgraded to make sure that what we get out of it
11 is reliable output?

12 I think that we need to go through this process
13 for some time and see what we learn from it. The industry
14 has also identified in their probabilistic safety assessment
15 applications guide that has been developed by NEI, which we
16 have looked at and I do think that's a pretty good start.
17 They have recognized the importance of a number of issues
18 that have been discussed here at this table. But I think
19 the real proof is going to be to apply these and see how
20 well it really works, what kinds of upgrades people come up
21 with to these PRAs as a result of this.

22 So, the process we're on is we're working with
23 industry/NEI working group. They have a guidance document.
24 It seems a fairly good document. There are some limitations
25 in it. We have identified those in a letter that I sent to

1 the industry, to NEI. They have, in fact, agreed with some
2 of the criticisms and have incorporated in their guidance
3 document. But what we said was we're not endorsing the
4 document at this point. What we want to do -- we think it's
5 a good start. What we want to do is to apply it. Let's
6 learn, let's see where we go.

7 May I have the next viewgraph?

8 [Slide.]

9 MR. THADANI: Now, again, this viewgraph reflects
10 that we do want to go beyond the early thinking of IPE and
11 what the value of these studies was. What I have here --
12 and I don't plan to go through all of the items, but what I
13 have here is some sense that as you go down on this list the
14 quality of PRA for that decision becomes even more and more
15 important.

16 Let me use operating reactor events. I think
17 there's some value of the IPEs. We take a look at the
18 event, try to understand its importance. There's no reason
19 why we can't use current IPEs to try and get better
20 understanding of the significance of those events. We've
21 not met any regulatory decision, but we have met -- the
22 decision we're making is let's better understand the event
23 and its importance and I think IPEs can help in that regard.

24 Going down to another example, for example the
25 second one from bottom is changes to technical

1 specifications. Issues came up and I will show you there's
2 a handbook we have put together as a result of some of the
3 issues that have come up. The issue came up they wanted to
4 change some limiting conditions of operations and they
5 wanted to conduct quarterly preventive maintenance
6 activities. If you extend the time period for operation if
7 there's a problem with the system and you do quarterly
8 testing, there are going to be periods when you will have
9 simultaneous components unavailable. PRAs don't do a good
10 job with that at all traditionally because they are based on
11 average outage times and they don't do a good job of
12 configuration control.

13 So, we recognize that, we develop models to be
14 able to deal with those issues and we have got this document
15 out to the industry, as a matter of fact, to make sure that
16 they understand what are some of these issues and what are
17 the limitations of current PRAs. In fact, there's a chapter
18 in here that tells them what kinds of changes to the models
19 they have to make. I think this is a good book. It's a
20 good heads up to the industry.

21 May I have the next viewgraph, please?

22 [Slide.]

23 MR. THADANI: So, while we're learning more and
24 more about these studies and make increased use, as you have
25 noted we have not done a very good job of whatever lessons

1 that are being learned to make sure that right people get
2 that information. We have now started a program to make
3 sure that as we finish a certain number of reviews, that the
4 review teams will go to each region. Starting next month,
5 as a matter of fact, there will be a team going to Region
6 III.

7 We expect before this program is completed, the
8 IPE review program is completed, we expect to visit each of
9 the regions with the team probably three times at each of
10 the regions. You want to go in with a fair number of
11 studies that the reviews have been completed on so that they
12 can get a good, broad understanding of some of the insights
13 that are coming out of these evaluations.

14 CHAIRMAN SELIN: Actually, one of the objectives
15 that Dr. Speis mentioned for the contract for the licensees
16 is at least as relevant to us, which is not to just contract
17 out all the work and have the expertise of a bunch of small
18 contractors. I'm not even comfortable with so much of the
19 work has been done in RES. It's in NRR and the regions that
20 we need to understand the dynamics of what goes in there.

21 Now, the regional inspector doesn't have to be
22 able to cross check which thermal hydraulic model was used,
23 but to really understand not just the numbers but the
24 results and what's vulnerable, that's the real payoff for us
25 of doing this.

1 MR. THADANI: We fully agree with you and, in
2 fact, even the next part that --

3 May I have the viewgraph --

4 MR. MILHOAN: The other part of this, Mr.
5 Chairman, is where we'll be reducing the senior reactor
6 analyst positions in the region. We'll add to the region
7 capability in this area in addition to Headquarters adding
8 some senior reactor analysts in their training program so
9 that we can improve the capability of the --

10 MR. THADANI: Yes. We're starting out with ten
11 positions, at least up front, two per region basically and
12 two here.

13 But I think it's even more -- could I have that
14 viewgraph number 21 back, please?

15 [Slide.]

16 MR. THADANI: The other part we want to do, and I
17 think this touches upon what you were saying, is to get this
18 information and this understanding at some level for the
19 residents as well so that the residents can take a look at
20 -- with those insights, take a look at operations,
21 maintenance, training, et cetera, that the licensees are
22 conducting and events that might happen, the significance of
23 those events. The residents are probably the most important
24 people in terms of their initial assessment of what is going
25 on.

1 So, our objective is to visit each of the plants
2 and make sure that the residents also have these insights
3 for their plant in particular.

4 We are trying more and more in our licensee
5 assessment activities to look at objective information based
6 -- to put that information in terms of its significance as
7 we assess licensee's performance. I think this activity
8 would help us do a better job in that area as well.

9 So, these are some of the thoughts that we have
10 now in terms of where we go from here.

11 I'll go back to Dr. Speis.

12 MR. MILHOAN: Right. That concludes our
13 presentation.

14 CHAIRMAN SELIN: But it doesn't really answer the
15 broader question. That says, what do we do with the
16 information we have? But I don't think -- following Dr.
17 Murphy's remark, I think it's sort of premature, but I think
18 we really do have to think really hard about how much muscle
19 we want to put behind a phase II of this work. As I said,
20 I'd be very much guided by where the industry comes in on
21 this one. We've said we can't make a safety case that we
22 need these PRAs in order to inspect the plants, but that
23 they certainly would be useful and efficient and good
24 pieces. So far, unless we go back and say that there's a
25 health and safety reason to require the PRAs, we need to

1 look to the putative beneficiaries of this result to see
2 what they want to do.

3 MR. THADANI: That's the path we're on now.

4 MR. MILHOAN: Mr. Chairman, that concludes the IPE
5 portion. We have a half hour remaining. We will attempt to
6 go through the severe accident research portion now.

7 Dr. Speis?

8 DR. SPEIS: The next viewgraph, page 22.

9 [Slide.]

10 DR. SPEIS: With the remaining time I'll attempt
11 to race through and kind of highlight some of the important
12 things we're doing in the severe accident research program.

13 I would like to point at the beginning that this
14 program was kind of refocused substantially in the early
15 '80s to focus on potential challenges to containment because
16 if you get involved with the severe accident degradation or
17 evolution and try to follow all the atoms and all the
18 pieces, you will never make any sense of what made sense.
19 How can you isolate the important phenomenal processes and
20 see which ones challenge the containment and then you are
21 beginning to make sense out of kind of isolate the important
22 things from the trivial in essence. I think we have made
23 substantial progress as a result of that.

24 Well, I have listed here, for example, the Mark I
25 liner. It was a vulnerability to affecting the -- leading

1 to early failure of the Mark I containment. I think we have
2 done a lot of work and this issue really has been behind us.
3 We have to look at the IPEs to make sure that the plants,
4 especially when they develop oxygen milestone procedures,
5 they have taken the insights into account, which is really
6 the availability of water at some point during the accident
7 evolution.

8 Likewise, another issue that was very important
9 for the last five or six or seven years, the direct hitting
10 of the containment where under high pressure conditions you
11 would reach the thermal equilibrium in the containment and
12 it's a kind of a thermodynamic fission process. All the
13 heat goes into pressurizing the containment, including the
14 burning of the additional hydrogen that is generated.

15 The other issues I have listed here, lower head
16 integrity, fuel-coolant interactions, hydrogen combustion.
17 Again, all these issues are important in affecting the
18 integrity of the various containment types.

19 [Slide.]

20 DR. SPEIS: If we go into a little bit more detail
21 as starting to the next viewgraph, page 23, I have already
22 talked about the Mark I liner, the early failure.

23 COMMISSIONER ROGERS: What do you really mean that
24 the early failure issue is considered resolved? I mean what
25 does that mean?

1 DR. SPEIS: Well, it was an issue --

2 COMMISSIONER ROGERS: Does it mean we understand
3 it --

4 DR. SPEIS: Yes, we understand it.

5 COMMISSIONER ROGERS: -- thoroughly enough that we
6 don't need to do anymore research?

7 DR. SPEIS: Exactly. We understand it, yes,
8 exactly. Maybe the wording is -- we understand it. There
9 was a time that the researchers and the technical community
10 were arguing whether water or no water makes a difference if
11 the failure probability is one, but that's not the case.
12 That issue has been resolved.

13 COMMISSIONER ROGERS: So, from a research point of
14 view.

15 DR. SPEIS: From a research point.

16 COMMISSIONER ROGERS: But not necessarily from an
17 NRR point of view.

18 MR. THADANI: Yes. But for your information, we
19 have -- I've asked that we take a specific look at Mark I
20 IPEs where they did level two type of analysis to see how
21 they treated liner melt issue and we find -- and I'm going
22 to have to confirm this. We found that essentially all the
23 plants have adopted procedures to be able to flood the lower
24 head for that liner melt issue.

25 So, I think the industry seems to have adopted

1 this view that it is the right thing to do and we're also
2 looking at the broad accident management program as well.

3 DR. SPEIS: Another important issue that was
4 dominating the scene for a long time, again as I said, was
5 the direct containment heating. That issue, after extensive
6 work, it's on its way to resolution also. We have done
7 extensive analytic experimental work by modeling a number of
8 plants and we find now that this issue is not -- this
9 phenomenon is not as threatening to containments as we
10 thought back at that time.

11 You remember, Commissioner Rogers, you were
12 involved in this. This was a daily occurrence in the
13 newspapers in those days, back in the late '80s, and also
14 this was identified in NUREG-1150.

15 So, I don't want to discuss this anymore. I would
16 like to go into some important things that we are addressing
17 now on page 26, lower head integrity.

18 [Slide.]

19 DR. SPEIS: I would like to say something about
20 this issue. Why is this important? Because before we had a
21 good understanding of the TMI accident, the thinking was
22 that once an accident is initiated it's going to take its
23 course and it's almost impossible to stop it and you almost
24 should assume simultaneous failure of the vessel. But the
25 TMI examination, the early part of it was done by the DOE

1 and the later part was sponsored by us in conjunction with
2 OECD countries, found out that the LWRs are very robust type
3 of plants and the accident evolves in a very slow, non-
4 coherent way. There is lots of time for things to happen
5 and if you have thought about some of those things a priori,
6 so you can intervene along the way and there is a good
7 chance that if those things have been thought carefully you
8 can avoid vessel failure and that was an important lesson
9 because there is a kind of a world of difference if you have
10 a severe accident and you're able to retain inside the
11 vessel versus it spills outside of the vessel like
12 Chernobyl. I'm sure it would have taken ten more years to
13 clean up the TMI if the later case.

14 So, we have focused quite a bit of work in this
15 area, especially even after the TMI VIP program, look at
16 some insights. The question is how do you cool the debris
17 in vessel and both by management of the accident in the
18 vessel or even by cooling the vessel from the outside? We
19 are addressing both of those issues more carefully. We have
20 a number of programs. We have completed the TMI, as I said
21 already.

22 [Slide.]

23 DR. SPEIS: On page 27 you see a number of
24 programs. We have an important program we have jointly with
25 OECD countries, the so-called RASPLAV Project. It involves

1 large quantities of real corium or real molten core material
2 and we're trying to measure the heat loads on the lower
3 vessel and see whether those heat loads can be taken care of
4 by cooling the vessel from the outside.

5 The project is making substantial progress. This
6 program has been performed at Krishatov Institute. We had
7 some concerns at the beginning, even though they were real
8 experts in materials area and some other technology areas,
9 whether they could put the whole thing together and be able
10 to work closely with us and have good dialogue and not been
11 seen as directing them and ordering them, but I think we
12 have overcome those difficulties.

13 The program made substantial progress last year in
14 addressing a number of issues, technical issues that were
15 questionable whether the program should go forward, but
16 there's no question now that the program should go forward
17 and some of those technical issues have been resolved.
18 We're working very closely not only with the Russians but
19 with the remaining of the international community.

20 We have some other programs. We have one at
21 Sandia looking experimentally to see the reactor pressure
22 vessel creep rupture failure criteria and also
23 simultaneously we're pursuing modeling this area.

24 So, again, the point is that it is an important
25 area, it has evolved based on our understanding of the TMI

1 accident and again in most of these areas we're working with
2 international community.

3 The next area I have listed here is fuel coolant
4 interactions. Again, if you have a severe accident, two
5 things can happen. The molten core will either interact
6 with water or with some other material, whether it is
7 concrete or steel. The question is under what conditions,
8 what constraints, how much the material can take place in
9 the interaction and FCI can be mild and it can also range
10 all the way to a more energetic so-called steam explosion
11 which was addressed first in the WASH-1400. Again, that
12 issue has received substantial attention both in the United
13 States and worldwide. There is a consensus that as far as
14 this failure mode leading to failure of the containment, the
15 probability is very low, but there are still some
16 difficulties in quantifying some element of the process and
17 we're doing some research in some well defined areas.
18 Again, this program is very well coordinated with related
19 international programs. For example, there's a program in
20 Insbruck where we're doing large pools of molten material
21 interacting with water to understand some of these things
22 more precisely.

23 [Slide.]

24 DR. SPEIS: On page 30 of the handout you see that
25 we're reconvening this June a steam explosion review group,

1 experts from the United States and worldwide. Birkhofer has
2 recommended two of the best people in Germany and likewise
3 Livalan in France and others will participate to take into
4 account all the most recent information and with the
5 remaining resources focus in some specific areas. So, I
6 think we have this area under control.

7 COMMISSIONER ROGERS: Just one little question.
8 On page 28, the last bullet says potential augmentation of
9 energetic steam explosions by chemical effects. Does that
10 involve borated water, the borated water question?

11 DR. SPEIS: No, no. This is if in the corium
12 there is substantial amounts of reactor zirconium or
13 aluminum. During the propagation of the explosion if there
14 are particles of aluminum they will chemically contribute to
15 the process itself. That's what we're talking about.

16 COMMISSIONER ROGERS: I see.

17 DR. SPEIS: This is what happened at the SL1
18 accident.

19 COMMISSIONER ROGERS: Well, there was an issue
20 raised, I know, as to whether the experiments that were done
21 with pure water actually were as relevant as those that
22 would be done in borated water and that there was a
23 substantial augmentation of steam explosions on the boration
24 of the water.

25 DR. SPEIS: Okay. The question there is about

1 triggering whether we propagation can be treated, whether
2 having a premixture which is ready to be triggered, whether
3 borated water will trigger it less or more.

4 COMMISSIONER ROGERS: Yes.

5 DR. SPEIS: You know, there are enough things to
6 trigger a potential explosion, so we're not paying too much
7 attention to the mechanisms for triggering. In most studies
8 we're assuming triggering has a probability of one.

9 What is important, there are other constraints in
10 defining the material that take part in the explosion and
11 that is the breakthrough that has taken place the last five
12 or six years, that there are limited quantities of materials
13 that can take part in an efficient interaction.

14 [Slide.]

15 DR. SPEIS: Hydrogen on page 31. A tremendous
16 amount of work has been done in this area, both here and the
17 people overseas are doing much more right now. I think we
18 have a basic understanding but there are some specific
19 issues dealing with specific scenarios and specific
20 containments. We're addressing issues like -- which are
21 kind of maybe a residual tourist, but that possibly could
22 have the higher consequences.

23 We're looking at the effect of high temperature on
24 the explosivity of hydrogen. Also, we're taking advantage
25 of some large scale facilities in Russia again where some of

1 the things that were addressed in the past will use small
2 scale facilities and researchers and analysts have raised
3 questions about their applicability to large scale systems.
4 So, we're taking advantage of some very expensive and well-
5 designed facilities in Russia to do large scale experiments
6 in this area.

7 [Slide.]

8 DR. SPEIS: On page 33 I have summarized the
9 source term research. I think that is a success story. We
10 finally completed the new source term. We've got the
11 blessing of, I think, you people and the ACRS after
12 extensive research. What we're doing in this area right now
13 we're only contributing to the PHEBUS Project. The PHEBUS
14 Project is kind of a big reactor and we'll be doing integral
15 experiments. We want to make sure that some of the
16 processes on an integral basis are still within our
17 understanding and our developing of the processes and the
18 phenomena and coming into our conclusions in this area.

19 I don't have anything to say right now about the
20 number of codes, but the computational tools is an important
21 part of our effort. Because of the time, I guess, I don't
22 have a presentation on that. I had earlier planned to
23 include that.

24 The only thing I can say as a conclusion in this
25 area, that we're working very closely with the Europeans and

1 the Russians and the Japanese. We're using some of our work
2 as levers. For example, our computational tools. In the
3 past we had lots of money and we were doing lots of
4 experiments now. Our resources are limited, so we kind of
5 participate jointly. I think in the future in this area
6 we'd like to participate as much as possible with our
7 limited resources to keep a kind of a maintenance program in
8 this area. But I basically feel that some of the important
9 issues and areas have been addressed, but specific issues
10 will arise once in awhile.

11 For example, the AP-600. When Ashok and company
12 were reviewing the AP-600, there was a scenario where the
13 containment finds itself full of hydrogen and steam and then
14 it was all of a sudden at some point condenses to steam and
15 the hydrogen appears by itself and what is the potential of
16 detonation and we had this specifically at Sandia and we
17 were able to do some good experiments in this area.

18 I had a beautiful art slide to show to you, but
19 I'm not too sure it can be shown.

20 Do you have that last slide? Here it is.

21 [Slide.]

22 DR. SPEIS: Maybe you'll agree with me that it's a
23 beautiful slide.

24 CHAIRMAN SELIN: It's a beautiful slide.

25 COMMISSIONER ROGERS: Yes, absolutely.

1 CHAIRMAN SELIN: One of the nicest I've seen.

2 DR. SPEIS: The question was there. If you look
3 at the bound of the -- this is the detonation conflagration.

4 CHAIRMAN SELIN: These are experimental results?

5 DR. SPEIS: No, this is theoretical, but I'll show
6 you the experimental. If you look at the outside boundary,
7 we were concerned that if all of a sudden you condensed the
8 steam you can raise and find yourself into the -- you see a
9 dotted line close to the detonation regime. The experiments
10 proved otherwise, that as soon as you -- this process is
11 limited. As soon as you condense you start burning the
12 hydrogen in a benign way and we stayed slightly at the line
13 and maybe at times slightly inside the outside lines. So,
14 we never went into the detonation regime.

15 If you want more details, I have Mr. Tinkler here
16 to discuss. But this is the type of work that comes in once
17 and a while on specific issues that are raised and becomes a
18 concern about the potential early failure of the
19 containment.

20 So, with that brief race through the program --

21 MR. THADANI: Themis, on that point, there are a
22 couple of items I think may be of interest to you.

23 In fact, this was critical to us when we were
24 reviewing System 80+ containment. We had to have this
25 information and we were very fortunate that Sandia was able

1 to run these tests. Not only did it help us in terms of
2 finally confirming the value of the igniters, but we also
3 got a lot of support in the location of igniters. That's
4 another very important element. There were some other tough
5 issues also for ABWR for example, some concerns about core
6 concrete interactions and what those might do to structural
7 capability of the containment. We got a lot of support from
8 research in some of their codes that have been developed so
9 far.

10 So, at least I do think that there have been real
11 concrete applications of some of the work that's been done.

12 DR. SPEIS: The other thing that is happening in
13 the severe accident area, there is an effort underway at
14 CSNI. We have put together the CSNI so-called senior group
15 of experts in Research a report, what is the research that
16 is important to be maintained or what are some of the
17 important areas that still has to be pursued. Not only in
18 severe accident, but in all areas of research.

19 We have a meeting in June 15 and 16 to shift
20 through and kind of prioritize some of these things and also
21 try to decide, see if there's a consensus which areas have
22 been resolved because people always come up with new areas
23 and new generational scientists and engineers appear on the
24 scene and they want to start things all over again. So,
25 we're trying to see if we can get some international

1 consensus to put some of these issues to bed technically.
2 It's a serious effort and I think it's going to be
3 successful to a large extent. Some of us are participating
4 in this effort.

5 So, with that, I --

6 MR. MILHOAN: This concludes our presentation that
7 we have.

8 CHAIRMAN SELIN: Thank you.

9 Commissioner Remick?

10 COMMISSIONER ROGERS: Well, just before we get
11 into anything else outside of research, has the IPE program
12 led to any research projects? Has anything come out of IPE
13 that looks like it ought to be looked at more from a
14 research point of view?

15 DR. SPEIS: No.

16 COMMISSIONER ROGERS: Well, on this severe
17 accident program, I think the Chairman cited your real
18 leadership in this whole thing, Dr. Speis, and I wanted to
19 reinforce that because I know this has been a long arduous
20 road to come to closure on this severe accident research
21 program. It has taken a concerted effort and a lot of
22 leadership to bring it to where it is and I certainly think
23 that you're deserving of very much commendation for fine
24 efforts here.

25 I really don't think that I have any additional

1 questions. I think we've cover, from my point of view, an
2 awful lot of ground today and I feel very comfortable with
3 where we are, but I'm not so sure where we're going. I do
4 think that a good deal of thought has to be given to the
5 next steps here. I agree with the Chairman that it's very
6 important to get together with the industry people and see
7 what they would see would be useful to them. It does occur
8 to me though that we might even have some additional reasons
9 beyond those that exist right now, possibly through
10 congressional action, with respect to risk-based regulation
11 that may, in fact, give support to moving further in this
12 direction without an explicit safety need. I don't know,
13 but I wouldn't be surprised if there was something that
14 emerged in that direction.

15 At any rate, moving ahead on risk-based
16 regulations certainly seems to be a course that we've been
17 on. I would hope that we would be able to have strong
18 support from industry that we continue to move in that
19 direction and that they participate in the next phases of
20 improvement of PRAs on their plans.

21 COMMISSIONER de PLANQUE: I have just a general
22 question in the research area. Just looking at your
23 upcoming meeting in May and other things and from what
24 you've said, there's certainly good cooperation now in the
25 international community in terms of sharing results and also

1 in certain cooperative projects that you've established
2 directly, for example those with the Russians.

3 But again, looking at short resources, both here
4 and in other countries I'm sure, is there more work being
5 done at the planning stages of research that would allow for
6 better coordination and lack of duplication up front at the
7 beginning end? Is that happening?

8 DR. SPEIS: Yes, it is happening. Again, the CSNI
9 vehicle is being very effective in this area because this
10 problem of research isn't only here but it's also -- all the
11 other countries are suffering from it. Everything that is
12 started now almost has been thought carefully by our
13 international bases and everybody is looking for partners.
14 So, if something doesn't make sense technically or it's not
15 the most cost effective or risk important program, it
16 doesn't happen because partners don't show up. So, I think
17 naturally it happens sometimes.

18 COMMISSIONER de PLANQUE: Survival of the fittest,
19 in other words.

20 MR. MILHOAN: That's correct.

21 COMMISSIONER de PLANQUE: Okay. Thank you very
22 much.

23 CHAIRMAN SELIN: Well, I would just like to
24 acknowledge the enormous contributions that you've made, Dr.
25 Speis, not only to the severe accident research program but

1 to a number of areas. I'm very pleased that in this final
2 summary of the severe accident research you're able to
3 report so much success. That's quite a monument to you, to
4 your own career and we're all very grateful for that,
5 particularly people who live near nuclear power plants.

6 DR. SPEIS: Mr. Chairman, I don't want to have the
7 last word, but I appreciate your kind words and Commissioner
8 Rogers', but I have been working very closely with a number
9 of people at the Office of Research and NRR, Thadani and
10 Brian Sheron, Farouk and all these people sitting here. So,
11 I want to make sure that they take most of the credit.

12 CHAIRMAN SELIN: That's very gracious of you, Dr.
13 Speis.

14 As far as this work goes, I think we've discussed
15 it somewhat extensively. If it is to continue to be work
16 that will simplify life, then the ball is in the industry's
17 court, other than to follow-up ourselves and get the
18 insights plant by plant that we can. If, on the other hand,
19 there is a proposal from the regulated community to go more
20 formally to a risk-based regulatory regime, then the
21 responsibility will be ours where we can be held responsible
22 for errors of omission and not just commission.

23 Right now, whatever we find in these reports is
24 gravy and if we miss some stuff, that's okay because they're
25 not our reports, they're the industry's reports. But if

1 they're to be the basis for a risk-based regulatory regime,
2 then our responsibilities become considerably greater, not
3 primarily in the analytical area but in setting out more
4 definitive criteria for what we will accept as an acceptable
5 PRA, what has to be done not only to have a plant acceptable
6 PRA but generically, industry wide and also for maintaining
7 these PRAs. That will be quite a different regime from the
8 one in which we're currently operating.

9 So, basically continue the work we're doing and
10 see what the industry proposes be done thereafter, unless,
11 of course, as Commissioner Rogers has so astutely pointed
12 out, the statutory regime changes. That would, of course,
13 lead to reconsideration of these remarks.

14 But I think this has been a very successful
15 effort. You guys have done a terrific job. I just want to
16 make absolutely sure that we don't inadvertently claim to do
17 more than we have or prepare the basis for people putting
18 more weight on what is after all a kind of a consistency and
19 rationality check, not an exhaustive review.

20 MR. MILHOAN: We certainly agree with that. We
21 will keep that in mind in characterizing any results of the
22 program, Mr. Chairman.

23 CHAIRMAN SELIN: Thank you very much, folks.

24 [Whereupon, at 11:56 a.m., the meeting was
25 concluded.]

CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON IPE PROGRAM AND SEVERE
ACCIDENT RESEARCH PROGRAM - PUBLIC
MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Wednesday, April 19, 1995

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: *Peter Lynch*

Reporter: PETER LYNCH



INDIVIDUAL PLANT EXAMINATIONS IPE FOR EXTERNAL EVENTS SEVERE ACCIDENT RESEARCH

April 19, 1995

T. P. Speis

Office Of Nuclear Regulatory Research

A. C. Thadani

Office Of Nuclear Reactor Regulation

OUTLINE

IPE Program

- **Goals and Accomplishments**

IPE Results

- **Plant Improvements and Vulnerabilities**
- **Generic Insights**
 - **Core Damage Frequency, Accident Sequences, Conditional Failure Probabilities**
 - **Variability In IPEs**
 - **Safety Goal**

IPE And IPEEE Program Status And Schedule

IPE Future Plans

Severe Accident Research

IPE PROGRAM

- **Licensee To Understand Severe Accidents And To Identify Related Vulnerabilities**
- **Issue Staff Evaluation Report To Licensee On Each IPE/IPEEE Submittal Review (Focus On Whether Licensee Met Intent Of Generic Letter Objectives)**
- **Staff To Document Significant Safety Insights From Examination of IPE Results (NUREG Report Focused At Providing Perspectives Of The Results From All The IPE Submittals)**
- **Input To Risk-Based Regulation**

GENERIC LETTER 88-20 GOALS ACHIEVED

Utilities Have:

- **Developed In-House Staff PRA Capabilities**
- **Performed A Level 1 And Level 2 PRA**
- **Generally Indicated Intention of Maintaining And Updating IPE: “Living PRA”**
- **Identified Plant Improvements As A Result Of IPE**

IPE INSIGHTS PROGRAM SCOPE

- (1) Examination Of Core Damage Frequency And Containment Performance Results**
 - **Generic LWR Results**
 - **Plant-Specific Results + Comparison Of Results Among And Within Various Plant Groups**
 - **Comparison Of Results With Safety Goals**
- (2) Examination Of Plant Changes/Improvements**
 - **Generic Versus Plant-Specific**
 - **Safety “Quantification” From Changes/Improvements**
- (3) IPE Information Being Collected In Database**
- (4) Examination Of IPE Models, Assumptions, Etc. With Respect To Potential Uses**

ALL PLANTS IDENTIFIED “IMPROVEMENTS” AS RESULT OF IPE

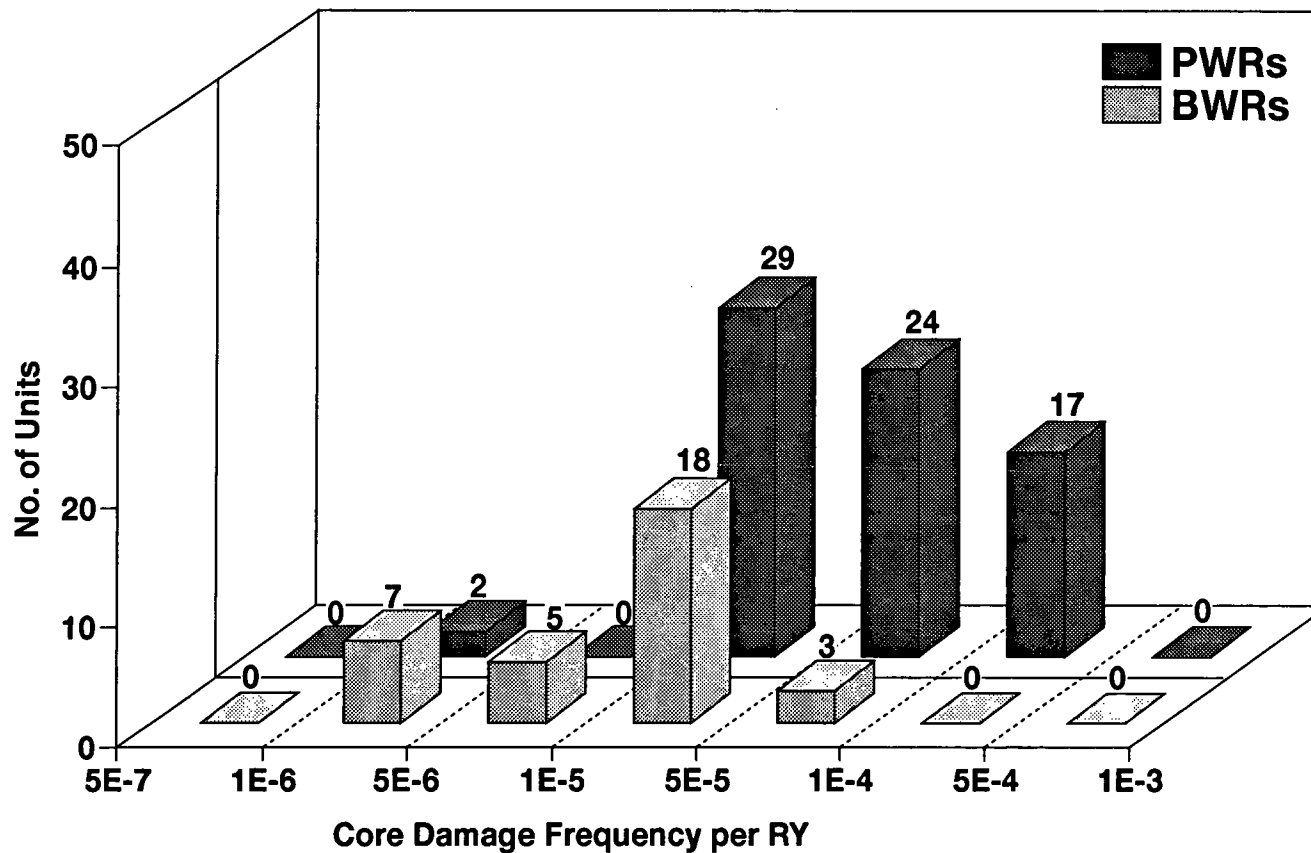
- **Improvements Decreased Core Damage Frequency**
- **Improvements Primarily Involve Changes To Operations,**
- **Involving Modifications to Operating Procedures And Training**
- **Many Of The Changes Are Being Planned And Under Evaluation For Implementation**

FEW PLANTS IDENTIFIED “VULNERABILITIES”

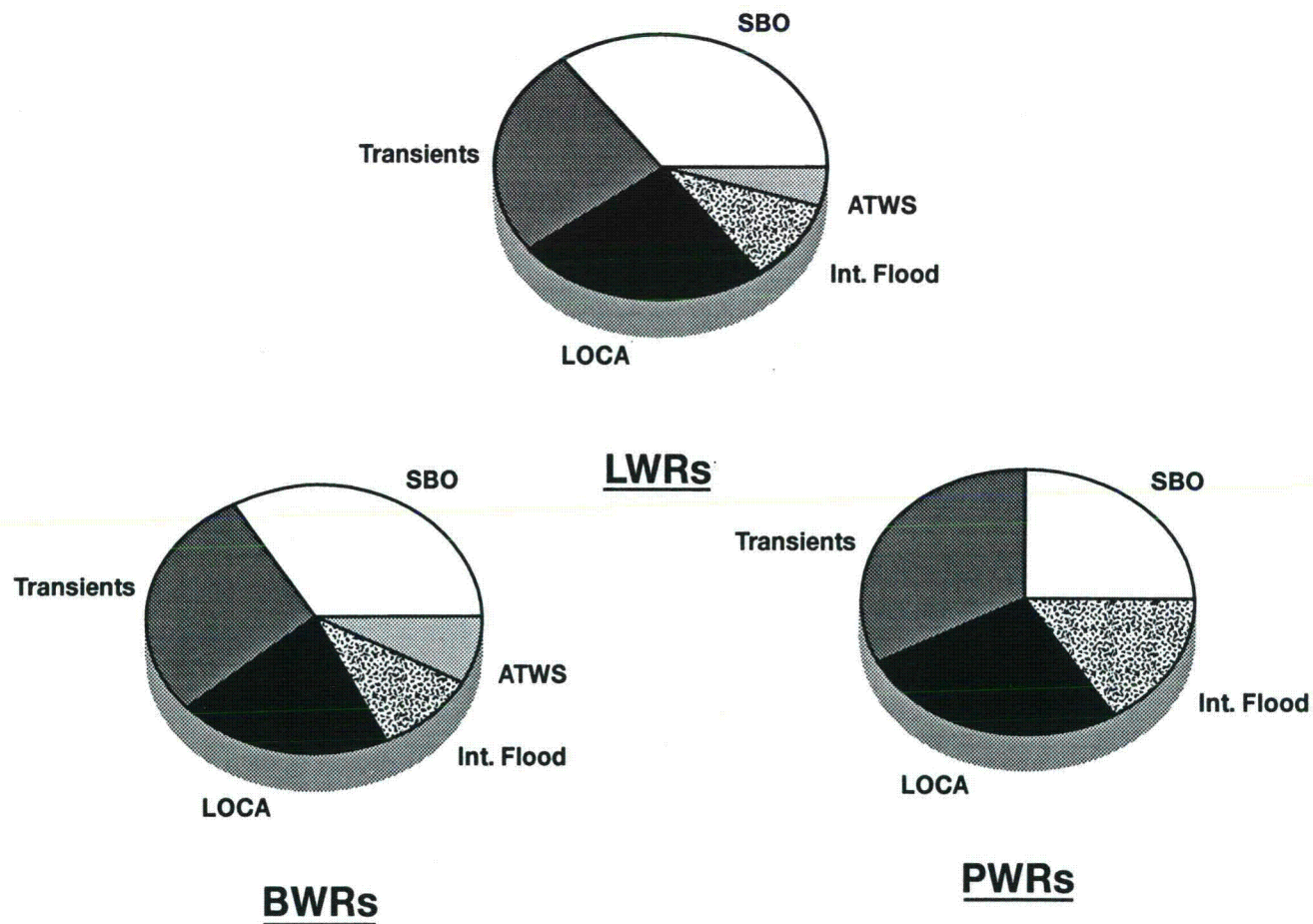
- **Licensee Defined What Is Meant By Vulnerability**
- **Variability In Licensee Definition Of Vulnerability;
For Example:**
 - **Core Damage Frequency Greater Than 1E-4**
 - **Accident Class Contribution Greater Than 50%**
 - **Specific Feature Outlier Compared To Similar Plant**
- **Vulnerabilities Identified:**
 - **Internal Flood (Surry)**
 - **Electric Power System (Palo Verde)**
 - **Low Reactor Water Storage Tank Capacity
(Haddam Neck)**
 - **Instrument Air System (Kewaunee)**

GENERIC INSIGHTS AND RESULTS (PLANT CORE DAMAGE FREQUENCY)

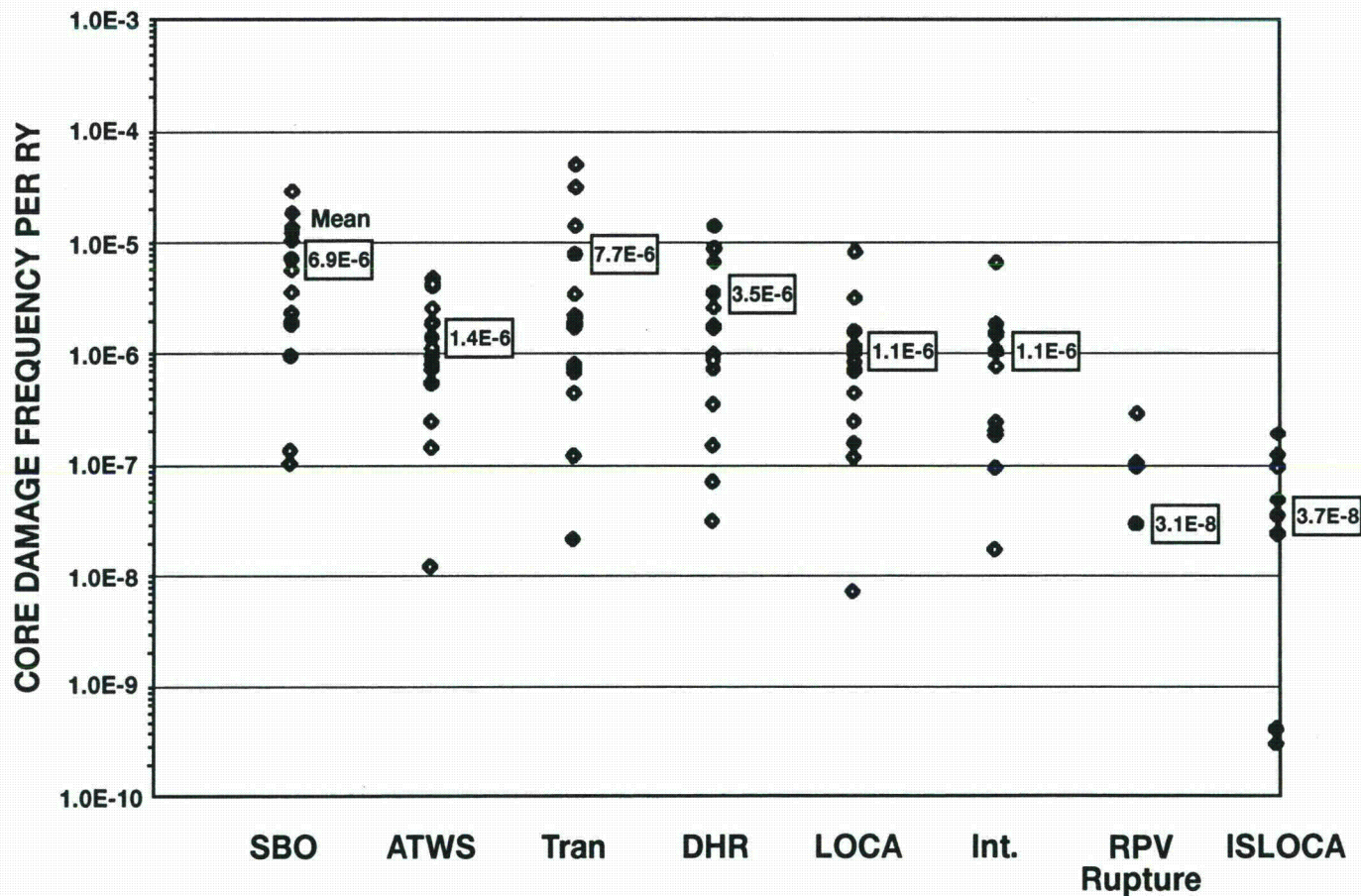
BWRs (34 Units, Mean CDF=2.2E-5)
PWRs (71 Units, Mean CDF=9.3E-5)



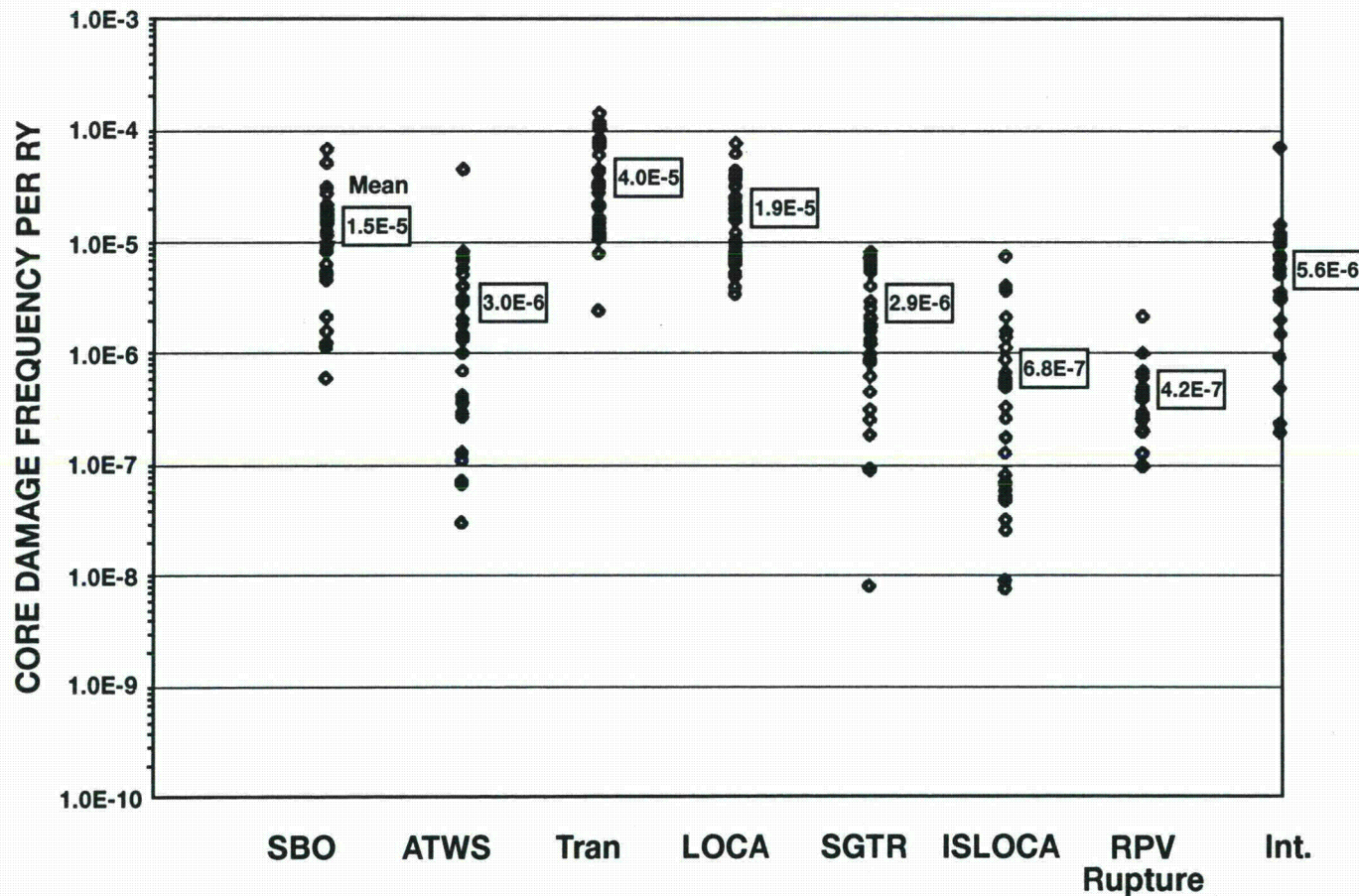
CORE DAMAGE FREQUENCY DOMINANT ACCIDENT SEQUENCES



VARIABILITY IN IPE RESULTS (BWR ACCIDENT SEQUENCES)

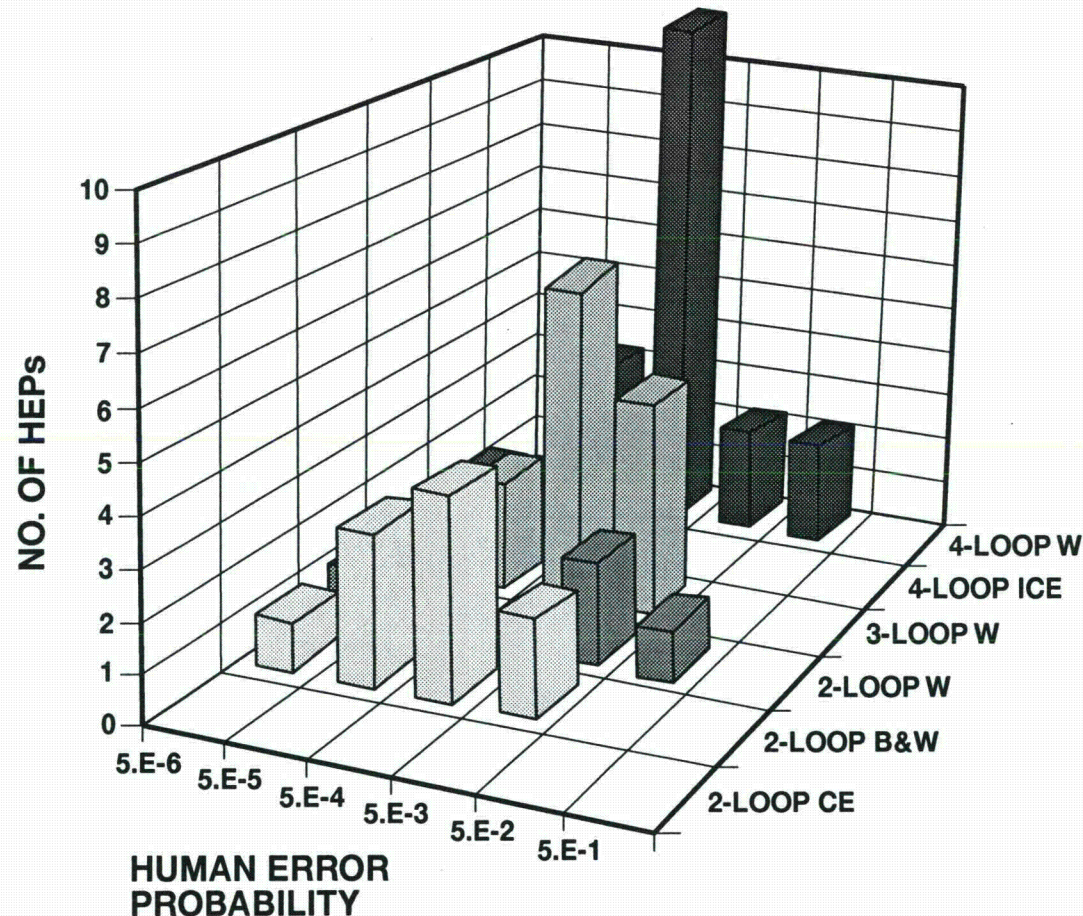


VARIABILITY IN IPE RESULTS (PWR ACCIDENT SEQUENCES)



VARIABILITY IN IPE RESULTS

(Operator Failure To Go To Recirculation)
(Only Plants With Manual Recirculation)



PRELIMINARY CONTAINMENT PERFORMANCE RESULTS

(Conditional Containment Failure Probabilities)

	PWRs(1)			BWRs(2)
	Large Dry	Sub	Ice	
Bypass	0.04	0.08	0.05	0.01
Early Containment Failure	0.07	0.16	0.02	0.22
Late Containment Failure	0.25	0.33	0.32	0.34
Intact	0.64	0.43	0.61	0.43

(1) Includes Data From 46 PWR Units

(2) Includes Data From 12 BWR Units

EXAMPLE IPE OBSERVATIONS ON CONTAINMENT FAILURE MODES

- **High Pressure Melt Ejection Usually Dominant Contributor To Early Failure For PWRs**
- **Variability In BWR Liner Melt-Through Contribution Due To Variability in Treatment**
- **Some Unique Failure Modes Observed:**
 - **Overpressurization Via Melt Of Downcomers For Mark IIs**
- **Main Contributor To Late Failures From Accumulation Of Non-Condensable Gases and Steam**
- **PWR Hydrogen Combustion Low Contributor**
- **Containment Isolation Failure Usually Small; However, Few PWRs Have Relatively Large Contribution (>10%) Because of Unisolated Small Penetrations**

VARIABILITY IN APPLICATION OF METHODS: ASSUMPTIONS, DATA, LEVEL OF DETAIL/RESOLUTION

FOR EXAMPLE:

Assumptions:

- **Core Damage Definition And Success Criteria**
- **Operator Reliability**
- **System And Component Operability**

Data:

- **Generic Versus Plant-Specific**

Level of Detail/Resolution:

- **Failure Modes Modeled**
- **Truncation Values Used In Core Damage
Frequency Quantification**

***Caution Is Needed In The Use Of The IPE Results
In Risk-Based Regulation***

INDIRECT COMPARISON TO SAFETY GOAL

- **Off-Site Consequences Generally Not Performed As Part Of IPEs**
- **Compare IPE Results Of Dominant Containment Failure Modes To NUREG-1150 And LaSalle Studies Results**
- **IPE Results For Population Of Plants Imply Risk Levels Below Individual Latent Cancer Fatality and Individual Early Fatality Health Objectives**

STATUS/SCHEDULE OF IPE PROGRAMS

IPE Submittal Reviews:

- **Accelerated Process**
 - **Issued 28 SERs**
 - **All Remaining IPE (50) Reviews In progress**
 - **Issue 5 SERs May 1995**
 - **Bulk Of Reviews To Be Completed By End December 1995**
 - **Estimated Completion Date: June 1996**
- **Involve Resident Inspectors Directly Into Review Process**

IPE Insights:

- **Issue Report On “IPE Perspectives On The Impact Of The Station Blackout Rule” In April 1995**
- **Issue Draft NUREG in January 1996**

STATUS/SCHEDULE OF IPEEE PROGRAMS

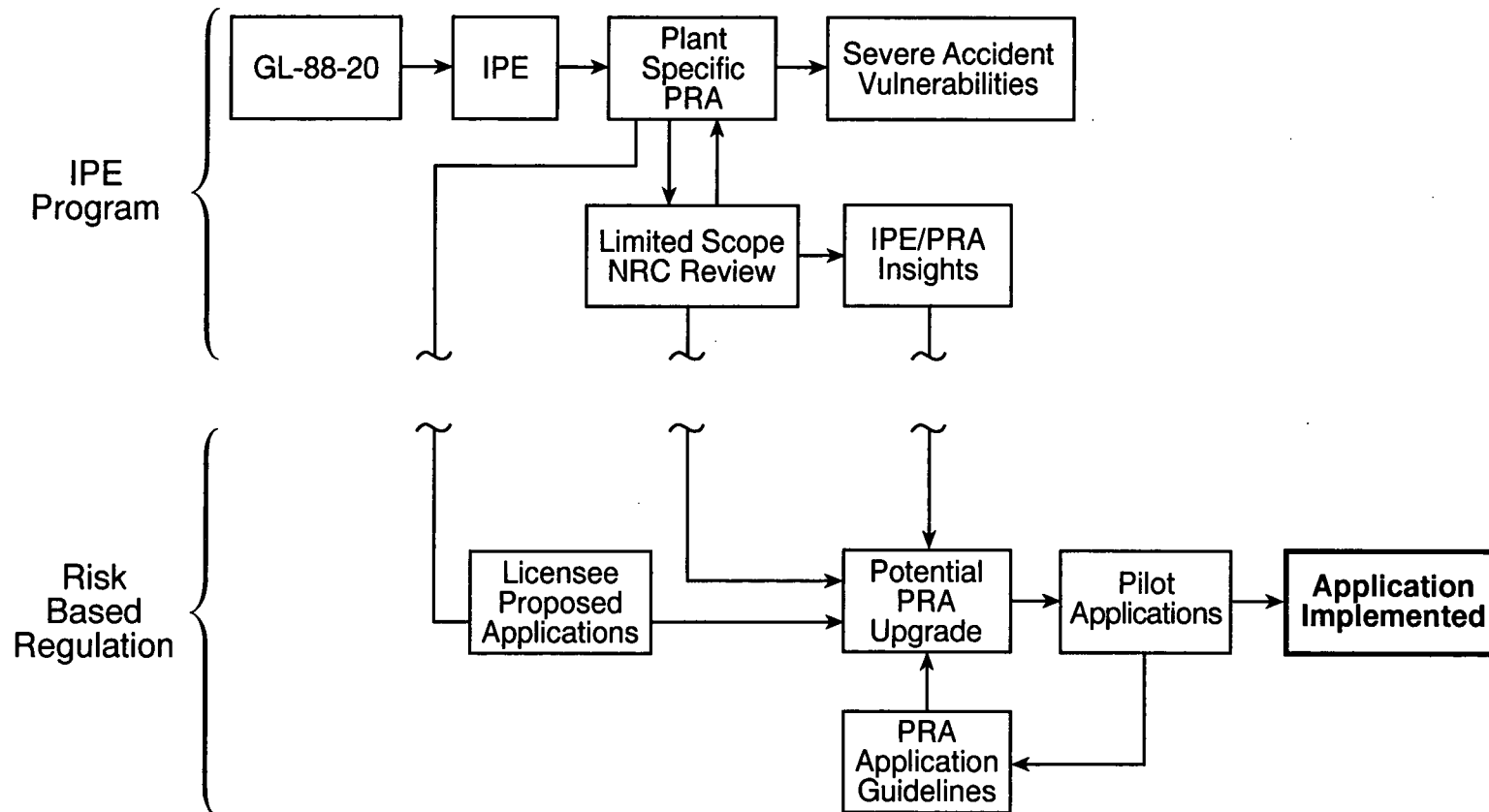
IPEEE Submittal Reviews:

- **6 IPEEE reviews In Progress**
- **Initiating 12 New Reviews**
- **Estimated Completion Date: End Of 1998**
- **Revisited Seismic Margin IPEEE Scope Due To New Livermore Hazard Curves**
 - **Proposed Staff Position Issued For Public Comment (Generic letter 88-20, Supplement 5)**
- **Integration Of IPEEE And A-46 Reviews, Plan Issued**

IPEEE Insights:

- **Insights Integrated With Review Through Senior Review Board**
- **Issue Revised Draft NUREG in 1998**
- **Present Plant-Specific IPEEE Results And Insights To Each Region**

RISKED BASED REGULATION



USE OF PRAS BEYOND IPE

- **Inspection Planning**
- **Safety Assessments Of Operating Reactor Events**
- **Licensee Justification For Continued Operation**
- **Identification of Risk Significant Equipment For Purposes Of Maintenance (e.g., Pilgrim, South Texas, Crystal River)**
- **Resolution Of Safety Issues Involving Existing Plant Equipment (e.g., Oconee/Keowee Dam)**
- **Changes To Technical Specifications (e.g., 11 Limited Conditions Of Operation Relaxed At South Texas)**
- **Safety Monitors (e.g., SONGS)**

MAKING EFFECTIVE USE OF IPE INSIGHTS

Regional Presentations:

- **Visit Each Region To Present Plant-Specific Insights To Inspectors**
- **Coordinated With Completion Of Each Submittal Review**
- **Present Up To 8 Plants Per Visit On “Round-Robin Basis”**

Site Activities:

- **Emphasis On Consideration Of Insights In Site Activities (i.e., Operations, Maintenance, Configuration Control, Training, Emergency Preparedness)**

SEVERE ACCIDENT RESEARCH

Severe Accident Research has focused on phenomena and issues to understand and quantify potential challenges to containment integrity for different US containment types

- **Mark I Liner**
- **Direct Containment Heating**
- **Lower Head Integrity**
- **Fuel-Coolant Interactions**
- **Hydrogen Combustion**
- **Source Term**

MARK I LINER EARLY FAILURE

Issue:

- **Early failure of the steel shell (liner) in a Mark I containment due to thermal attack by core debris**

Status:

- **NUREG/CR-5423 concluded that liner failure virtually certain (probability ~ 1) without water; highly unlikely (probability $\sim 10^{-4}$) with water on the drywell floor**
- **Further confirmatory research addressed residual uncertainties raised in peer review on melt release conditions, melt spreading, melt-concrete interactions, and liner failure temperature**
- **Confirmatory research, documented in NUREG/CR-6025, confirmed findings of NUREG/CR-5423; the Mark I liner early failure issue is considered resolved**

DIRECT CONTAINMENT HEATING

Issue:

- **Early containment failure of PWR reactor containments due to high pressure melt ejection and heating of containment atmosphere.**

Status:

- **Completed large scale integral tests simulating the Zion and Surry plants and completed evaluation of containment loads versus containment structural capability.**
- **Issued peer reviewed reports, NUREG/CR-6075 and NUREG/CR-6109, which concluded for Zion and Surry that there was no realistic probability of containment failure.**

DIRECT CONTAINMENT HEATING

(Continued)

Plans:

- **Examination and extrapolation of findings to population of PWR reactors, extrapolation of conclusions to Westinghouse and B&W reactors is underway; resolution report due June.**
- **Resolution of DCH for CE designs requires additional testing (due to design differences) now underway; scheduled for completion in September 1995. Issue resolution report targeted for December 1995.**
- **All DCH issue resolution research, including peer review, to be completed by July 1996.**

LOWER HEAD INTEGRITY

Issues:

- **Under what conditions can molten core material be retained in the reactor pressure vessel (RPV) through internal or external cooling (e.g., ex-vessel flooding for AP600)?**
- **If the RPV were to fail, what is the likely failure mode, location, and timing?**

Status:

- **TMI Vessel Investigation Project**
 - **Results showed high temperature on inner RPV wall in hot spot region (~ 11000C)**
 - **In-vessel cooling mechanisms helped prevent RPV from failing via creep rupture**

LOWER HEAD INTEGRITY

(Continued)

- **OECD RASPLAV Project**
 - **Experimental work (with prototypic corium composition) and analysis of natural pool convection and heat flux distribution on RPV lower head**
- **External flooding**
 - **Experimental work on ex-vessel flooding (e.g., data and analysis of downward facing boiling and critical heat flux)**
- **Lower head failure experiments**
 - **Experimental work on RPV creep rupture failure (data and analysis on timing and size of failure)**
- **Model development will proceed based on experimental data**

FUEL-COOLANT INTERACTIONS (FCI)

Issues:

- **Assess the consequences of FCIs (ranging from mild quenching to energetic steam explosions)**
- **Under what conditions must energetic steam explosions be considered and what are reasonable estimates for the energetic yield?**
- **Potential augmentation of energetic steam explosions by chemical effects**

FUEL-COOLANT INTERACTIONS

(Continued)

Status:

- **Issue addressed in WASH. 1400, NUREG-1150, SERG (NUREG-1116) and more recently by CSNI specialists meeting (NUREG/CP-0127, NEA/CSNI/R(93)8)**
- **General agreement that +/-failure is of very-low likelihood and that future efforts (experimental/ analytical) should be focused on further quantification of steam explosions where some residual questions remain and there is the need for additional confirmatory work**

FUEL-COOLANT INTERACTIONS

(Continued)

Future Plans:

- **Reconvene steam explosion review group**
- **Take into account most recent CSNI specialists meeting information/conclusions**
- **Review any additional experimental data/modeling insights**
- **Include ex-vessel FCIs**
- **Continue model development/experimental program considering review group recommendations**

HYDROGEN COMBUSTION

Issue:

- **Assess potential challenges to containment integrity resulting from various modes of hydrogen combustion during severe accidents**

Status — Experiments:

- **High temperature, high speed hydrogen combustion experiments at BNL on inherent detonability, deflagration to detonation (DDT) with and without venting, and hot jet initiation (joint NRC/NUPEC support)**
- **Hydrogen combustion experiments at Cal Tech on diffusion flame stability and expansion of high speed jet into explosive mixture**

HYDROGEN COMBUSTION

(Continued)

- **Experiments on hydrogen combustion behavior at SNL in steam condensing environments during severe accidents**
- **Experiments at Russian Research Center to study hot turbulent jets, DDT, and separation criteria for placing hydrogen igniters inside containment**

Analysis:

- **HMS code to calculate hydrogen migration and mixing in the containment**

SOURCE TERM RESEARCH

- **Understanding and Modeling of Severe Accident Phenomena**
 - **Extensive Computer Code Development to Model Severe Accident Phenomena Including Core Heatup and Melt Progression, Fission Product Release and Transport, Retention in Primary Coolant System, and Aerosol Behavior Within Containment.**
 - **Codes Based on Fundamental Principles Coupled With Results From Numerous Small Scale Experiments**
- **Determination of Risk Important Accident Sequences**
 - **Determine the Dominant Accident Sequences From a Risk and a Phenomenological Point of View Using Insights From Probabilistic Risk Assessment Studies (e.g., WASH-1400, NUREG-1150).**

SOURCE TERM RESEARCH

(Continued)

- **Utilization of Computer Codes to Calculate Fission Product Release and Transport Behavior for Those Sequences Important to Risk for a Representative Group of Plants (NUREG-1150).**
- **Compilation and Analysis of Above Calculations Used to Develop Updated Source Term (NUREG-1465) to Replace That of TID-14844.**
- **Ongoing PHEBUS Integral Experiments Will Confirm Our General Understanding (If Needed, Upgrade Computer Codes) of Fission Product Release and Transport**

BACKUP SLIDES

FUEL-COOLANT INTERACTIONS EXPERIMENTAL WORK

- **FARO/KROTOS - large scale experiments on non-explosive interactions (e.g., melt breakup and quenching) and medium scale experiments on explosive interactions**
- **Univ. of Wisconsin experiments on explosive and non-explosive interactions, including premixing phenomena and energy conversion**
- **ANL experiments on chemical augmentation of molten Zircaloy-water-steam explosions**
- **Univ. of California (SB); premixture sizes/properties (i.e., premixture limitations); propagation (microinteraction behavior)**
- **Outside the U.S.; Japan, Germany, UK**

FUEL-COOLANT INTERACTIONS ANALYTICAL WORK

- **IFCI code - SNL**
- **ESPROSE-M code, UCSB (DOE funded)**
- **Texas code - Univ. of Wisconsin**
- **PM-ALPHA (NRC/DOE) vs CHYMES (UK)
comparisons**
- **France, Germany (TRIO MC, EVA3)**

The above listed codes handle various aspects of the steam explosion methodology, such as premixing, propagation, etc.

EX-VESSEL DEBRIS COOLABILITY

Issue:

- **Coolability of molten core debris released from an RPV onto the containment floor when water is added to the debris**

Status:

- **Limited number of ex-vessel coolability tests conducted with reactor materials (MACE tests under a cooperative program with DOE, EPRI, and 14 other international organizations) and with simulant materials (SWISS and WETCOR tests)**

EX-VESSEL DEBRIS COOLABILITY

(Continued)

- **Results are inconclusive with regard to long term debris coolability; significant heat extraction from debris observed in the short term followed by stable crust formation**
- **Recent large scale MACE test M3 (1.2m x 1.2m section, 2000 kg melt), conducted 3/20/95, aborted due to overpressurization of test section; investigation underway**

Plans:

- **Future experimental program contingent upon findings of M3 failure and agreement by the MACE consortium members to fund the program**

SEVERE ACCIDENT CODES

Objective:

- **To provide the capability to model plant accidents and transients to assist the NRC in resolving safety issues and in incorporating research results into the regulatory process**

NRC-Supported Codes:

- **MELCOR: Integral systems level code to analyze severe accidents and consequences in nuclear power plants from initial core uncover, through reactor vessel failure and containment response**
- **SCDAP/RELAP5: Detailed mechanistic code to analyze in- vessel severe accident progression including thermal hydraulics, core melting, and reactor vessel failure**

SEVERE ACCIDENT CODES

(Continued)

- **CONTAIN:** Detailed code for analysis of severe accident phenomena inside containment, including aerosol and fission product behavior, flammable gas combustion, melt-concrete interactions and direct containment heating.
- **IFCI:** Integrated Fuel-Coolant Interactions code to model in-vessel and ex-vessel explosive and non-explosive phenomena
- **VICTORIA:** Detailed code to analyze fission product release and transport in the reactor coolant system during a severe accident including vapor deposition, resuspension and revaporization
- Completed extensive independent peer review of MELCOR, SCDAP/RELAP5 and CONTAIN leading to recommendations for modeling improvements that have been implemented into the codes