UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON IPE PROGRAM AND SEVERE

ACCIDENT RESEARCH PROGRAM

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PUBLIC MEETING

U.S. Nuclear Regulatory Commission

One White Flint North

Rockville, Maryland

Wednesday, April 19, 1995

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

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission

KENNETH C. ROGERS, Commissioner

E. GAIL de PLANQUE, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

JOHN HOYLE, Secretary of the Commission

KAREN CYR, General Counsel

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

THEMIS SPEIS, Deputy Director, Office of Nuclear Regulatory Research

JOSEPH MURPHY, Special Assistant, RES

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

MARY DROUIN, IPE/IPEEE Section Leader, RES

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

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

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

Commissioner Rogers?

Commissioner de Planque?

Mr. Milhoan?

MR. MILHOAN: Good morning, Mr. Chairman and

Commissioners.

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

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

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

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

Following the IPE presentation and discussion, Dr. Spies will summarize some of the more important ongoing activities in severe accident research area. As you've noted, I think, in your briefing slides, we have a large number of topics to discuss today, so I think we'll go ahead and proceed and may have to assess near the end where we stand as we go through the slides.

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

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

The next viewgraph shows the outline of the presentation.

[Slide.]

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

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

[Slide.]

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

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

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

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

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

[Slide.]

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

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

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

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

[Slide.]

DR. SPEIS: The next viewgraph summarizes our belief that the IPE, the goals of the generic letter have been achieved. I think it's the consensus of the staff here that the utilities have met the goal, are meeting the goal of the generic letter basically. They have developed in-house staff PRA capabilities. In the old days, when a utility wanted to do a PRA, they would hire a contractor and the contractor will go into the plant and do the PRA and then later on, I guess, the technical organization would put into a shelf there. One of the things that we were discussing during the development of the IPE program that it was important for the staff to participate, the technical people there so they can understand and digest insights because that's what the essence of the program was.

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

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

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

DR. SPEIS: Yes.

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

DR. SPEIS: Yes.

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

DR. SPEIS: Yes.

CHAIRMAN SELIN: Is that correct?

COMMISSIONER ROGERS: Yes.

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

DR. SPEIS: Yes, that's right.

CHAIRMAN SELIN: Is that correct?

DR. SPEIS: Absolutely right.

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

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

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

DR. SPEIS: Yes.

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

DR. SPEIS: Exactly.

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

DR. SPEIS: I think you are about right.

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

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

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

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

CHAIRMAN SELIN: Please.

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

Number two is are there some significant outliers as a result of our looking at it. So, the focus of the review was not necessarily to look at what I would say to really dig deep into the quality of the study, but enough to say did they identify something that might be significant. That is, the key was to look for outlier plants.

CHAIRMAN SELIN: Okay.

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

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

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

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

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

CHAIRMAN SELIN: Okay. Fair enough.

COMMISSIONER ROGERS: Before we leave, I've got a couple too.

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

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

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

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

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

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

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

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

MS. DROUIN: One of the things that we do look at at the review is the level of participation by the licensee and how much contractor help. In terms of the details of thermal hydraulics running some of the more sophisticated codes, they tended to rely on contractors. But when it gets into the systems analysis and the accident sequence delineation, the staff has pretty much done that work on their own with guidance from contractors. The level of degree, of course, has varied from licensee to licensee, but I would say that at least 50 percent if not more than that have done the bulk of the work themselves from what we've seen.

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

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

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

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

COMMISSIONER ROGERS: This question of the living PRA, I have a couple questions about that. One is are we considering as included in the definition of a living PRA the concept of a dynamical PRA? In other words, a living PRA might be the best conditions of the plant and the PRA that leads to that and then when you make a change in something in the plant on a permanent basis you redo the PRA and in that sense it's a living document, as distinct from what I'd call a dynamic approach. Namely, well, when you're taking certain systems out of service for maintenance and so on and so forth, without making a fundamental change in the plant design, that changes the PRA. That changes the bottom line. And to what extent the dynamical aspects as contrasted with the kind of updating that has to be included in the usual interpretation of a living PRA.

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

DR. SPEIS: Ashok, go ahead.

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

As far as the dynamic effects, it's driven largely by licensee applications and what we're seeing is increasing interest on the part of the licensees to, in fact, make such use of these PRAs. South Texas had come in for some relaxation of some technical specifications which was driven by their plans to conduct certain preventive maintenance at power. Again, the idea of configuration became very significant and that's a dynamic aspect. So, they had to go back and modify the models actually in their PRA to be able to do that and we reviewed and approved those changes.

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

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

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

COMMISSIONER ROGERS: Right.

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

COMMISSIONER ROGERS: And then the other question had to do with the extent to which there was consistency in the use of data, generic data versus actual data for the plant. There's some suggestion that licensees may have made the choice to use generic data when that happened to look a little bit better and actual performance data on their own plants when that looked at little bit better. It seems to me there is a question here that we have to pursue as we go ahead. I think that may not be the big question right at this point, but again it's involved in the follow-on. But there I think we're going to have to try to see that there is some standard way of approaching it. If there really is data, actual performance data on equipment in the plant, that should be used, not generic data that happens to be a lot more favorable.

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

COMMISSIONER ROGERS: Yes.

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

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

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

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

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

COMMISSIONER ROGERS: Very good. Thank you.

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

[Slide.]

DR. SPEIS: Okay. The next viewgraph will get into the IPE Insights Program scope. As I say, we looked carefully at the core damage frequency, containment performance results. We look at the generic results, LWR. We will take a look at the plant-specific results. We'll do comparisons among and within various plant groups and then do comparisons with the safety goal.

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

COMMISSIONER de PLANQUE: I understand all the things that you would like to interpret from the results. But in your examining the results, are you going to be able to go back and look at the very kind of thing that Commissioner Rogers was just mentioning, the type of data that went into it? Was it generic data?

DR. SPEIS: That will be part of --

COMMISSIONER de PLANQUE: You will be doing that?

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

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

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

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

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

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

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

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

MR. MURPHY: We'll be looking at the spread over all the plants and when they're grouped tightly together we won't look that carefully. Where there's a broad spread, we'll look and see why the spread. That will take up perhaps into seeing whether it's plant-specific that's doing it versus generic, different modeling of a given component. For instance, there are a lot of different models that have been used in reactor coolant pump seals. That could cause a difference in spread for some things and we'll be able to identify what made something high and what made something low, what would the source of -- not only that there's a variability, but what the source of that variability is.

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

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

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

MR. MURPHY: That's true. What we hope to do -- now, we do a limited review, but our review is focused on the boundary conditions and assumptions of the analysis with a basic assumption that I don't think is too bad, that the basic detail of the fault trees and event trees tend to be done reasonably well. If you focus on the boundary conditions and the assumptions and the basic models that are used, you probably don't do too badly in coming up with a feel for the goodness of the work that was done.

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

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

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

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

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

[Slide.]

DR. SPEIS: The next one, page 6, summarizes the improvements, all plants identified improvements as a result of IPE. Again, based on what we have reviewed, all these improvements decreased the core damage frequency to some extent. Some of them more than some others, some others less.

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

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

DR. SPEIS: Yes.

[Slide.]

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

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

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

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

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

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

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

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

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

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

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

COMMISSIONER ROGERS: Right. Right.

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

[Slide.]

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

CHAIRMAN SELIN: Well, it's certainly not science, Dr. Speis. This is the chart in your whole file that I had the least confidence in of any one at all.

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

MR. MILHOAN: We try.

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

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

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

MR. MILHOAN: No, we didn't.

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

CHAIRMAN SELIN: Right.

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

I'm sorry I interrupted you.

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

MR. THADANI: If I may comment, I personally certainly agree with your view that one has to be very careful in terms of the bottom line estimates out of IPEs, but I think the real value -- well, at least qualitatively I think there's useful information here. What it says is you would expect boiling water reactors to have lower core damage frequency than pressurized water reactors. I think you can probably substantiate that by understanding of how boiling water reactors operate and the kinds of systems that they have.

CHAIRMAN SELIN: But you had that coming into this.

MR. THADANI: I agree. I agree.

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

MR. MILHOAN: We totally agree.

DR. SPEIS: This is their numbers.

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

MR. MILHOAN: That's exactly correct.

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

MR. MILHOAN: That's entirely correct.

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

[Slide.]

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

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

DR. SPEIS: It's mostly a --

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

MR. THADANI: ATWS is not a significant

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

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

[Slide.]

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

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

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

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

DR. SPEIS: Yes, go ahead.

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

CHAIRMAN SELIN: What you've cited is interesting, but it's more functional. In other words, one element across the board versus another one across the board, which is a very interesting answer. What I was trying to get at is sort of a simpler thing. Can we have confidence that if a plant says that station blackout is twice as important as LOCA that, in fact, that's right? In other words, that they did the station blackout and the LOCA analysis in comparable fashion or could one have been --

MR. MILHOAN: Within an individual IPE.

CHAIRMAN SELIN: Within an individual IPE.

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

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

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

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

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

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

CHAIRMAN SELIN: I see.

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

[Slide.]

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

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

[Slide.]

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

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

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

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

DR. SPEIS: This is conditional to the event. Given a LOCA or given a transient which leads to a LOCA and eventually when the operator has to go down there and make the switch from the injection into the circulation, this is the error that was assumed and we want to find why. What is the reason for it? Is it the timing or some other things that are not obvious to us? Because, when all of us talk about risk-based regulation, you know, somebody will come in with a proposal or submittal and he will have a low error or a high error and then we will have to decide whether it makes sense or it's important enough that it has an effect on what he is proposing to do.

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

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

COMMISSIONER ROGERS: There's nothing for CE plants.

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

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

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

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

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

DR. SPEIS: They still have a manual --

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

[Slide.]

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

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

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

Under the ice condenser, for example, you see here early containment failure the number is .02 and we don't understand this because unless for those ice condensers the contribution of station blackout is zero -- but we don't think that's the case because if station blackout is still important they will take the igniters out, okay, and the igniters are there to burn the hydrogen in a controlled manner and if you lose the igniters you start accumulating hydrogen and you could fail early. So this .02 is kind of low and so it doesn't --

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

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

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

So, again, these are the type of things.

Also --

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

DR. SPEIS: Yes.

COMMISSIONER ROGERS: Why is that so different?

DR. SPEIS: Why it's so low?

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

DR. SPEIS: This .16?

COMMISSIONER ROGERS: Yes, compared to the other PWRs.

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

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

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

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

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

[Slide.]

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

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

And the other area is against a success criteria, so it's another important area. Some people have used the FSAR values, which is the design basis which we know it is conservative. Some other ones have gone way into the spectrum of optimism by doing detailed calculations which we have not reviewed, and some of them are somewhere in-between.

We already discussed the human error, which varies widely.

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

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

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

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

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

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

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

COMMISSIONER ROGERS: But, I mean, I think that the Chairman's question earlier, where do we go from here, I think that's the important thing.

DR. SPEIS: That's right.

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

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

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

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

When you do your perspectives and your views and where we go from here, my conclusion at this point is we may have learned something useful about the plants but we didn't learn a lot about the process because it wasn't much of a process to begin with. I wouldn't like us to spend too much time trying to figure out all the ways people did things different other than to work with NEI on what happens on the next wave, if there is a next wave.

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

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

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

DR. SPEIS: But, Mr. Chairman, I don't want to argue with you --

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

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

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

DR. SPEIS: We agree with you.

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

But the key thing is what have we learned about our plants sort of one at a time and then by class. And when you do write your lessons learned, I --

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

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

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

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

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

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

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

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

I think we have a further goal ahead of us that says that how we can use a PRA, whether it's an IPE or something else, depends on, number one, the goodness of the PRA, and, number two, the extent to which we have reviewed it. And that varies for different applications, so in some applications the IPE may be sufficient or sufficient with minor fine tuning. In other cases, it may take a very detailed review because subtle differences can make a big difference and require a very high quality job.

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

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

On the other hand, it seems to me that -- and the cost of doing something like that to start now would be pretty significant, I think.

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

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

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

CHAIRMAN SELIN: You know, what Dr. Murphy said I thought was very well taken, that you're in the middle of the street and you've got a bright street lamp at the corner, so that's where you look even though you know you lost the watch in the middle of the street. We haven't finished the detailed analysis, so we're in a position to talk about the methodology.

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

MR. MILHOAN: Absolutely.

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

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

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

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

The reason I make this point is we don't have a regulatory basis for requiring that these studies be done at this next level, be done. What we do have is some carrots we can hold out which says that these are important, they're useful, we hope you folks will keep these up yourself. And if you think that overall we'll end up with a more efficient regulatory basis by having PRAs that we both understand and that we can both live with, we think we can simplify the piece, but that's got to be voluntary because we don't have a safety basis for requiring these at this point.

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

But if we want to have a more efficient regulatory basis which is built on these types of PRAs, we need more uniform analyses. Not only higher quality, but more uniform analyses, more standard analyses, than we have today. Then it's sort of up to the industry to decide whether they just want to live with the status quote, as inefficient as it is, or they want to work cooperatively with us. But if they want to do the second one, then there have to be industry standards with which we concur on how to do an IPE and use that as the basis for something which we certainly can't do today, which is to put them in and say, "We can use your numbers to, say, target our inspections or to decide which rules make sense and which don't." We can't do that today with these analyses or with our understanding.

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

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

MR. MILHOAN: You're entirely correct.

MR. THADANI: We fully agree with you.

CHAIRMAN SELIN: Dr. Speis?

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

CHAIRMAN SELIN: Please.

[Slide.]

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

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

[Slide.]

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

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

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

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

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

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

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

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

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

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

COMMISSIONER ROGERS: So, it will be in there?

DR. SPEIS: Yes.

[Slide.]

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

COMMISSIONER ROGERS: Seismic.

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

Another thing we're doing, we're carefully integrating the Generic Issue A-46 which deals with seismic response to the IPEEE, so we don't repeat things twice basically.

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

CHAIRMAN SELIN: To answer all the questions.

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

[Slide.]

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

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

So, there was limited scope and the staff in the generic letter, as a matter of fact, indicated some simplified approaches would be acceptable and they did not have to do a more expensive probabilistic risk assessment. Fortunately, licensees went beyond what was said in the generic letter and essentially all of them have done PRAs. Most of them have actually done level 2 type of PRA studies. So, to that extent, I think they've gone beyond what was the intent of the generic letter.

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

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

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

But that information alone does not still lead to a view that says if you take care of this, you'll end up with a high quality PRA. I think as I said earlier, the real value is going to be to go through the lower part of that chart. It's kind of hard to see, I think, for some people. But the idea simply is as follows. Let's take a look at specific applications that the industry is interested in making PRAs. Let's look at the PRA at that point and from all the lessons that we have learned take a specific look at that part of the PRA to see how well that part was handled. At that point, make a decision, is the study itself good enough for that application or does it need to be upgraded to make sure that what we get out of it is reliable output?

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

So, the process we're on is we're working with industry/NEI working group. They have a guidance document. It seems a fairly good document. There are some limitations in it. We have identified those in a letter that I sent to the industry, to NEI. They have, in fact, agreed with some of the criticisms and have incorporated in their guidance document. But what we said was we're not endorsing the document at this point. What we want to do -- we think it's a good start. What we want to do is to apply it. Let's learn, let's see where we go.

May I have the next viewgraph?

[Slide.]

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

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

Going down to another example, for example the second one from bottom is changes to technical specifications. Issues came up and I will show you there's a handbook we have put together as a result of some of the issues that have come up. The issue came up they wanted to change some limiting conditions of operations and they wanted to conduct quarterly preventive maintenance activities. If you extend the time period for operation if there's a problem with the system and you do quarterly testing, there are going to be periods when you will have simultaneous components unavailable. PRAs don't do a good job with that at all traditionally because they are based on average outage times and they don't do a good job of configuration control.

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

May I have the next viewgraph, please?

[Slide.]

MR. THADANI: So, while we're learning more and more about these studies and make increased use, as you have noted we have not done a very good job of whatever lessons that are being learned to make sure that right people get that information. We have now started a program to make sure that as we finish a certain number of reviews, that the review teams will go to each region. Starting next month, as a matter of fact, there will be a team going to Region III.

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

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

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

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

May I have the viewgraph --

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

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

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

[Slide.]

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

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

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

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

I'll go back to Dr. Speis.

MR. MILHOAN: Right. That concludes our presentation.

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

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

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

Dr. Speis?

DR. SPEIS: The next viewgraph, page 22.

[Slide.]

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

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

Well, I have listed here, for example, the Mark I liner. It was a vulnerability to affecting the -- leading to early failure of the Mark I containment. I think we have done a lot of work and this issue really has been behind us. We have to look at the IPEs to make sure that the plants, especially when they develop oxygen milestone procedures, they have taken the insights into account, which is really the availability of water at some point during the accident evolution.

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

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

[Slide.]

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

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

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

COMMISSIONER ROGERS: Does it mean we understand it --

DR. SPEIS: Yes, we understand it.

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

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

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

DR. SPEIS: From a research point.

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

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

So, I think the industry seems to have adopted this view that it is the right thing to do and we're also looking at the broad accident management program as well.

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

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

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

[Slide.]

DR. SPEIS: I would like to say something about this issue. Why is this important? Because before we had a good understanding of the TMI accident, the thinking was that once an accident is initiated it's going to take its course and it's almost impossible to stop it and you almost should assume simultaneous failure of the vessel. But the TMI examination, the early part of it was done by the DOE and the later part was sponsored by us in conjunction with OECD countries, found out that the LWRs are very robust type of plants and the accident evolves in a very slow, non-coherent way. There is lots of time for things to happen and if you have thought about some of those things a priori, so you can intervene along the way and there is a good chance that if those things have been thought carefully you can avoid vessel failure and that was an important lesson because there is a kind of a world of difference if you have a severe accident and you're able to retain inside the vessel versus it spills outside of the vessel like Chernobyl. I'm sure it would have taken ten more years to clean up the TMI if the later case.

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

[Slide.]

DR. SPEIS: On page 27 you see a number of programs. We have an important program we have jointly with OECD countries, the so-called RASPLAV Project. It involves large quantities of real corium or real molten core material and we're trying to measure the heat loads on the lower vessel and see whether those heat loads can be taken care of by cooling the vessel from the outside.

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

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

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

So, again, the point is that it is an important area, it has evolved based on our understanding of the TMI accident and again in most of these areas we're working with international community.

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

[Slide.]

DR. SPEIS: On page 30 of the handout you see that we're reconvening this June a steam explosion review group, experts from the United States and worldwide. Birkhofer has recommended two of the best people in Germany and likewise Livalan in France and others will participate to take into account all the most recent information and with the remaining resources focus in some specific areas. So, I think we have this area under control.

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

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

COMMISSIONER ROGERS: I see.

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

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

DR. SPEIS: Okay. The question there is about triggering whether we propagation can be treated, whether having a premixture which is ready to be triggered, whether borated water will trigger it less or more.

COMMISSIONER ROGERS: Yes.

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

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

[Slide.]

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

We're looking at the effect of high temperature on the explosivity of hydrogen. Also, we're taking advantage of some large scale facilities in Russia again where some of the things that were addressed in the past will use small scale facilities and researchers and analysts have raised questions about their applicability to large scale systems. So, we're taking advantage of some very expensive and well-designed facilities in Russia to do large scale experiments in this area.

[Slide.]

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

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

The only thing I can say as a conclusion in this area, that we're working very closely with the Europeans and the Russians and the Japanese. We're using some of our work as levers. For example, our computational tools. In the past we had lots of money and we were doing lots of experiments now. Our resources are limited, so we kind of participate jointly. I think in the future in this area we'd like to participate as much as possible with our limited resources to keep a kind of a maintenance program in this area. But I basically feel that some of the important issues and areas have been addressed, but specific issues will arise once in awhile.

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

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

Do you have that last slide? Here it is.

[Slide.]

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

CHAIRMAN SELIN: It's a beautiful slide.

COMMISSIONER ROGERS: Yes, absolutely.

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

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

CHAIRMAN SELIN: These are experimental results?

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

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

So, with that brief race through the program --

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

In fact, this was critical to us when we were reviewing System 80+ containment. We had to have this information and we were very fortunate that Sandia was able to run these tests. Not only did it help us in terms of finally confirming the value of the igniters, but we also got a lot of support in the location of igniters. That's another very important element. There were some other tough issues also for ABWR for example, some concerns about core concrete interactions and what those might do to structural capability of the containment. We got a lot of support from research in some of their codes that have been developed so far.

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

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

We have a meeting in June 15 and 16 to shift through and kind of prioritize some of these things and also try to decide, see if there's a consensus which areas have been resolved because people always come up with new areas and new generational scientists and engineers appear on the scene and they want to start things all over again. So, we're trying to see if we can get some international consensus to put some of these issues to bed technically. It's a serious effort and I think it's going to be successful to a large extent. Some of us are participating in this effort.

So, with that, I --

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

CHAIRMAN SELIN: Thank you.

Commissioner Remick?

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

DR. SPEIS: No.

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

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

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

COMMISSIONER de PLANQUE: I have just a general question in the research area. Just looking at your upcoming meeting in May and other things and from what you've said, there's certainly good cooperation now in the international community in terms of sharing results and also in certain cooperative projects that you've established directly, for example those with the Russians.

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

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

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

MR. MILHOAN: That's correct.

COMMISSIONER de PLANQUE: Okay. Thank you very much.

CHAIRMAN SELIN: Well, I would just like to acknowledge the enormous contributions that you've made, Dr. Speis, not only to the severe accident research program but to a number of areas. I'm very pleased that in this final summary of the severe accident research you're able to report so much success. That's quite a monument to you, to your own career and we're all very grateful for that, particularly people who live near nuclear power plants.

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

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

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

Right now, whatever we find in these reports is gravy and if we miss some stuff, that's okay because they're not our reports, they're the industry's reports. But if they're to be the basis for a risk-based regulatory regime, then our responsibilities become considerably greater, not primarily in the analytical area but in setting out more definitive criteria for what we will accept as an acceptable PRA, what has to be done not only to have a plant acceptable PRA but generically, industry wide and also for maintaining these PRAs. That will be quite a different regime from the one in which we're currently operating.

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

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

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

CHAIRMAN SELIN: Thank you very much, folks.

[Whereupon, at 11:56 a.m., the meeting was 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: Carol 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

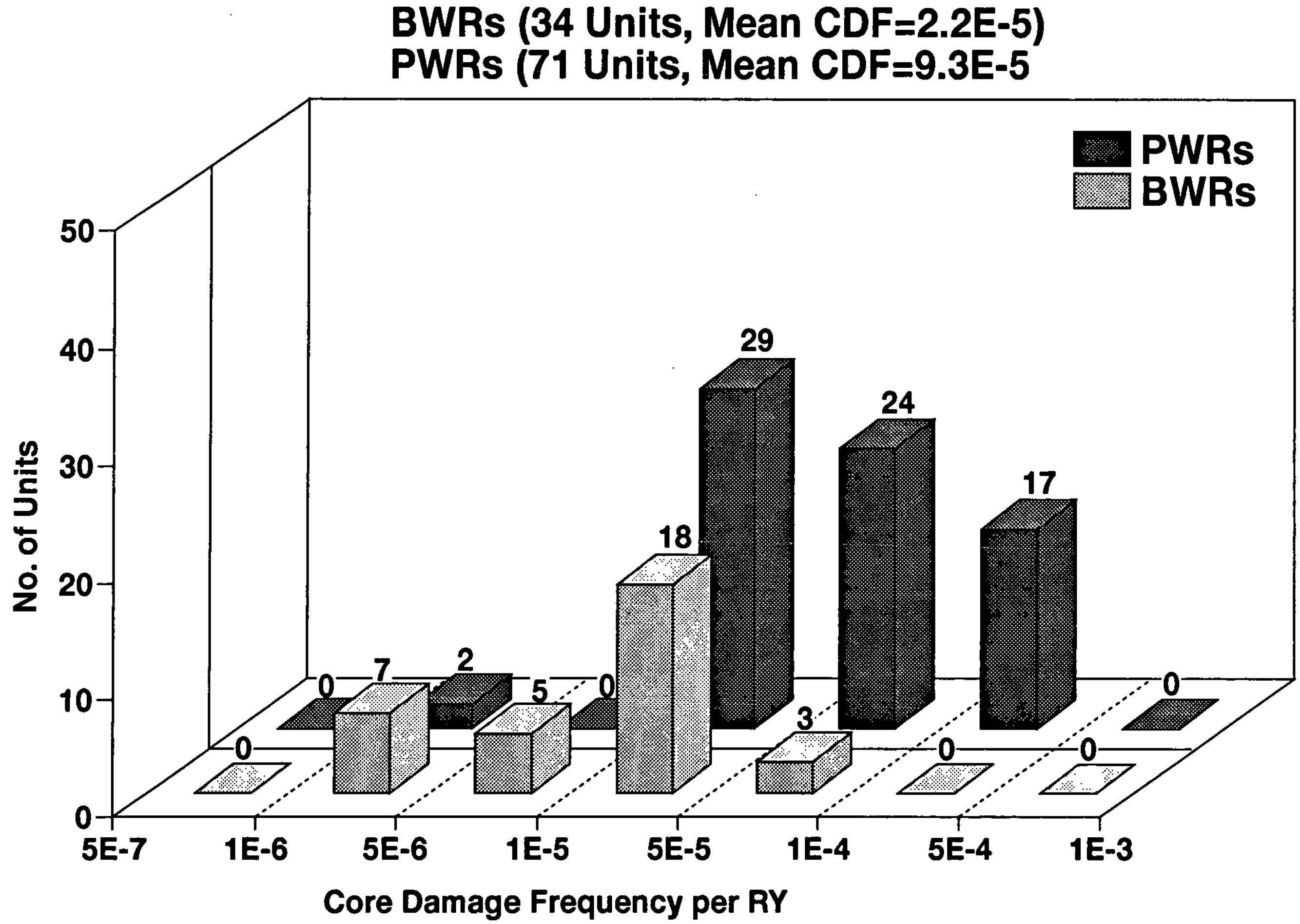
ALL PLANTS IDENTIFIED "IMPROVEMENTS" AS RESULT OF IPE

- 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

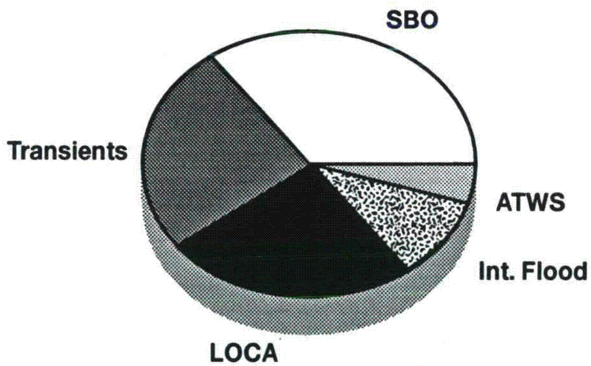
FEW PLANTS IDENTIFIED "VULNERABILITIES"

- 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)

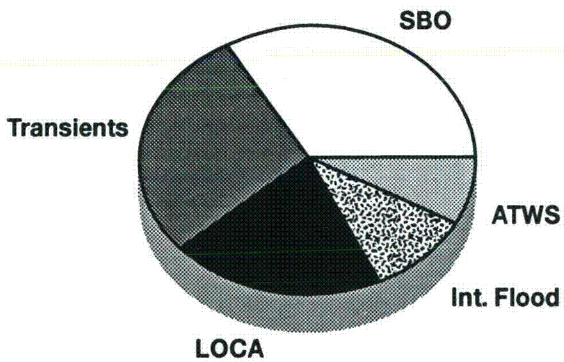
GENERIC INSIGHTS AND RESULTS (PLANT CORE DAMAGE FREQUENCY)



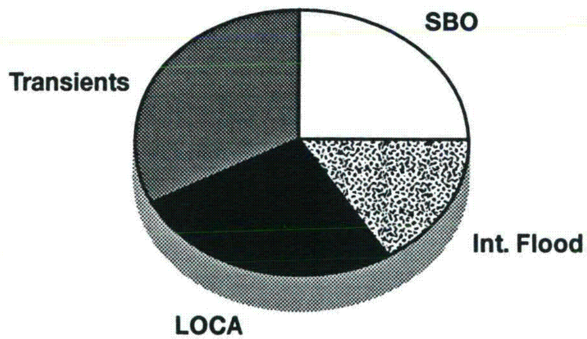
CORE DAMAGE FREQUENCY DOMINANT ACCIDENT SEQUENCES



LWRs

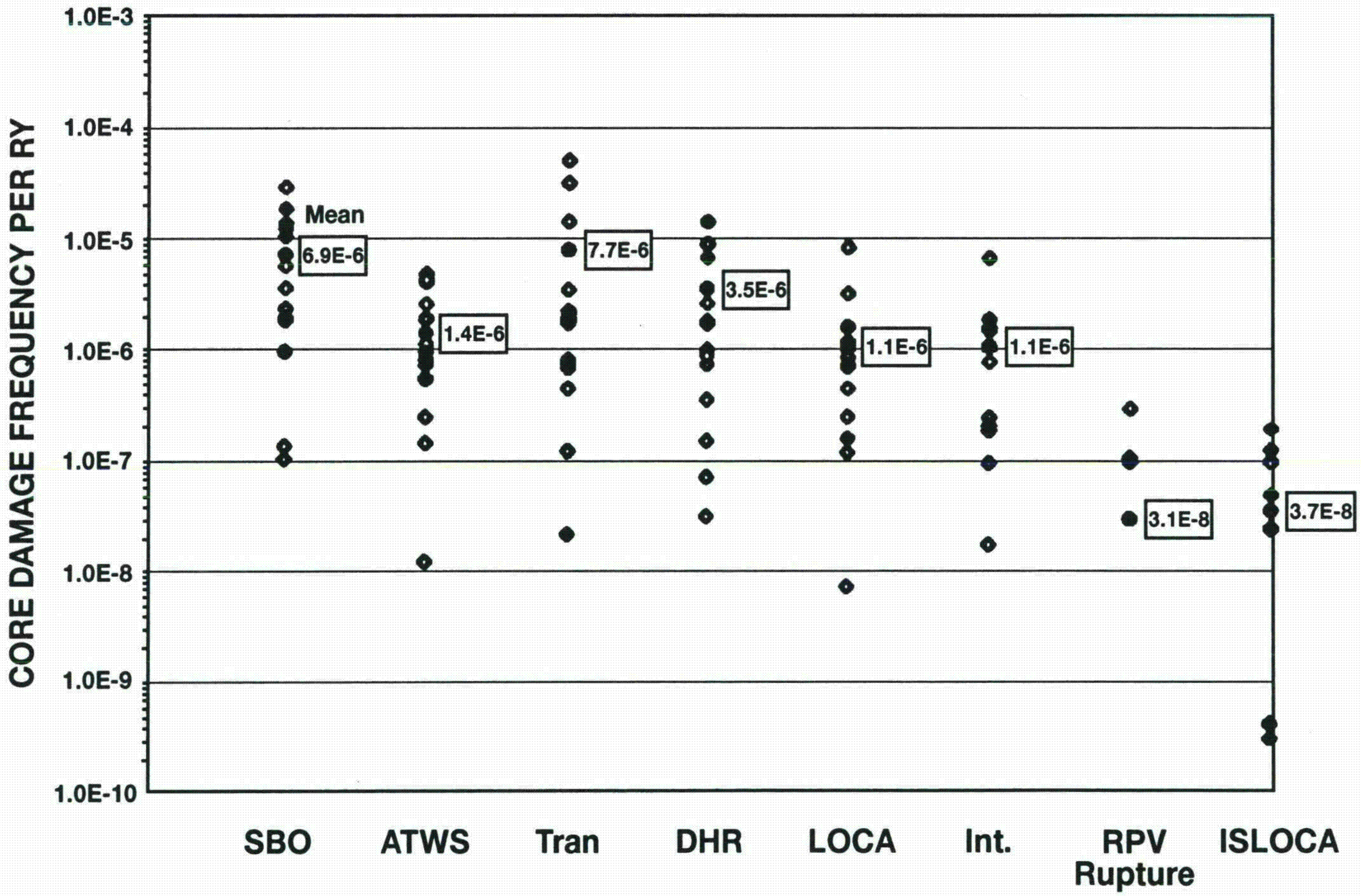


BWRs

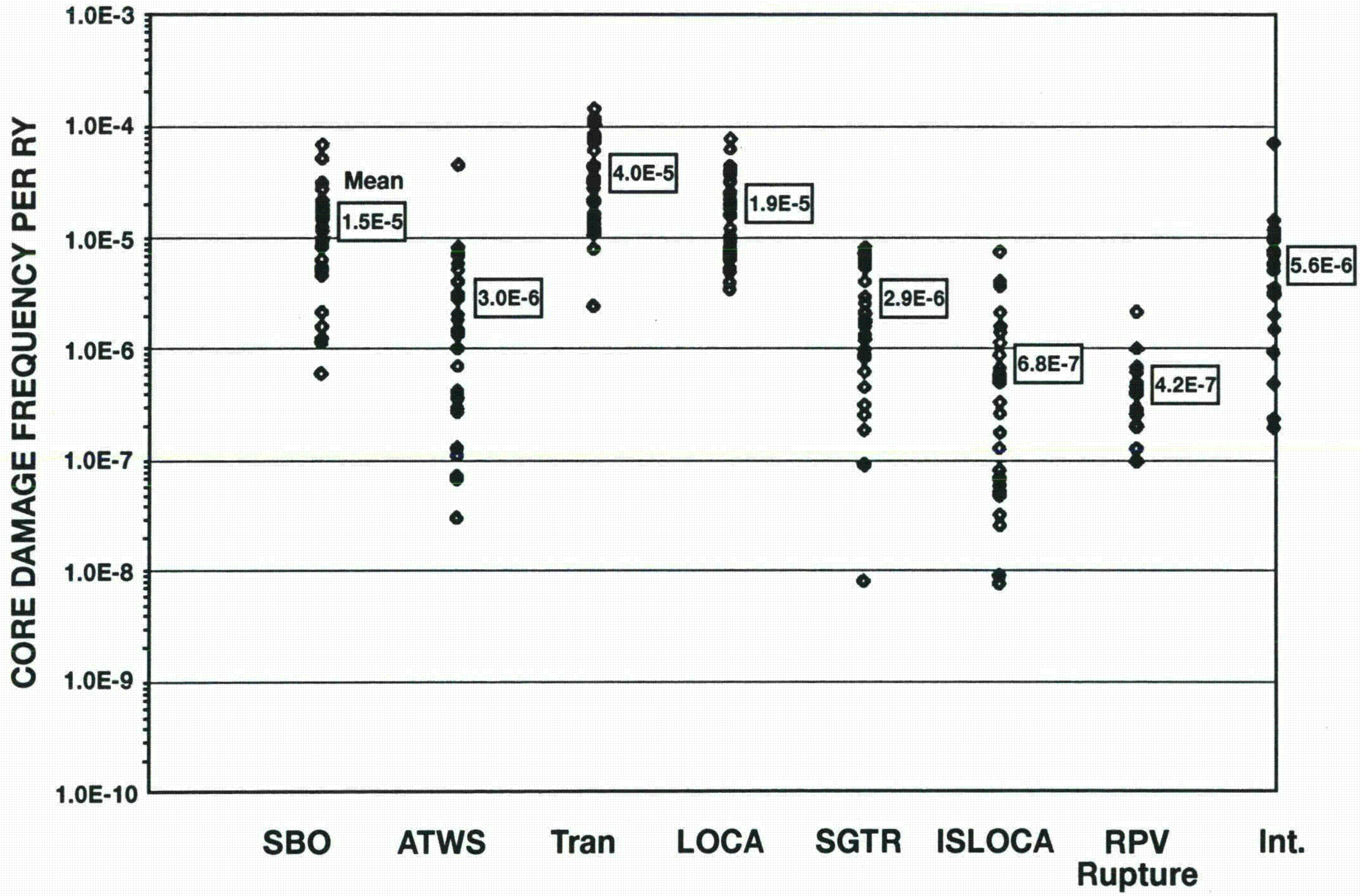


PWRs

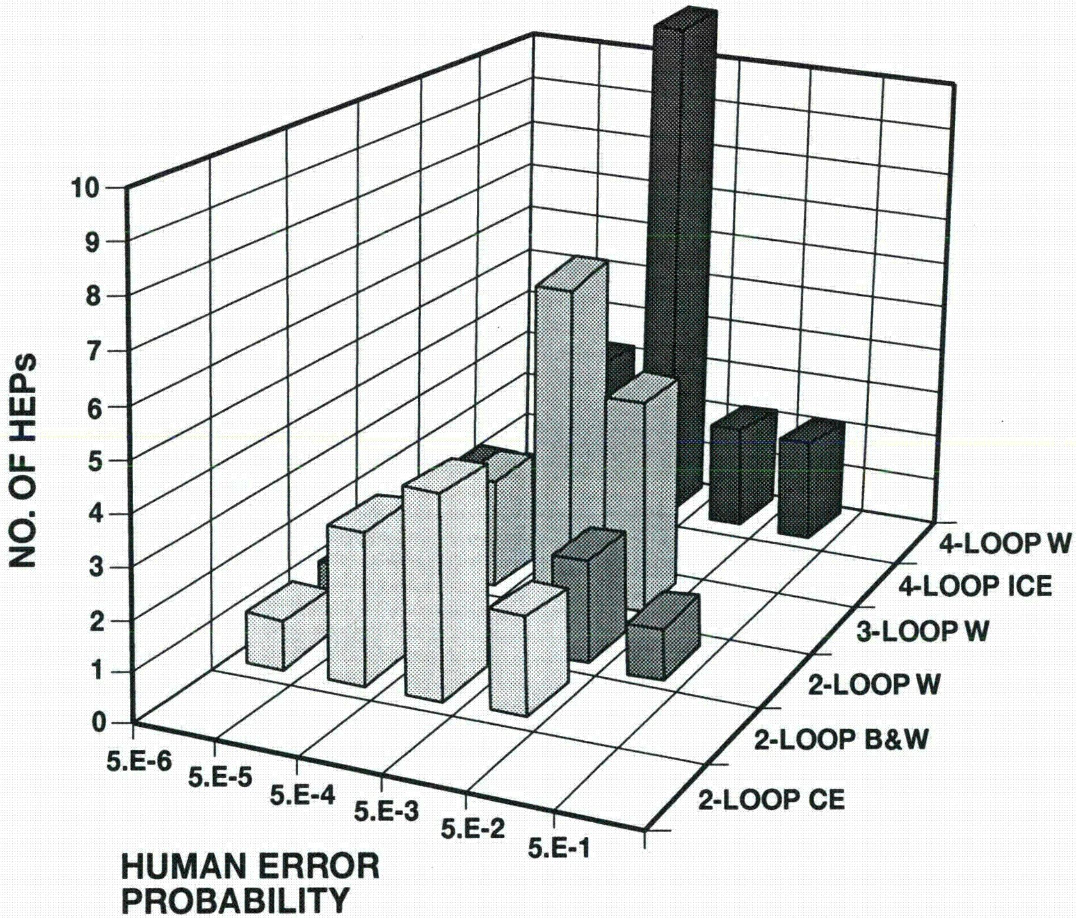
VARIABILITY IN IPE RESULTS (BWR ACCIDENT SEQUENCES)



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-Condensible 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

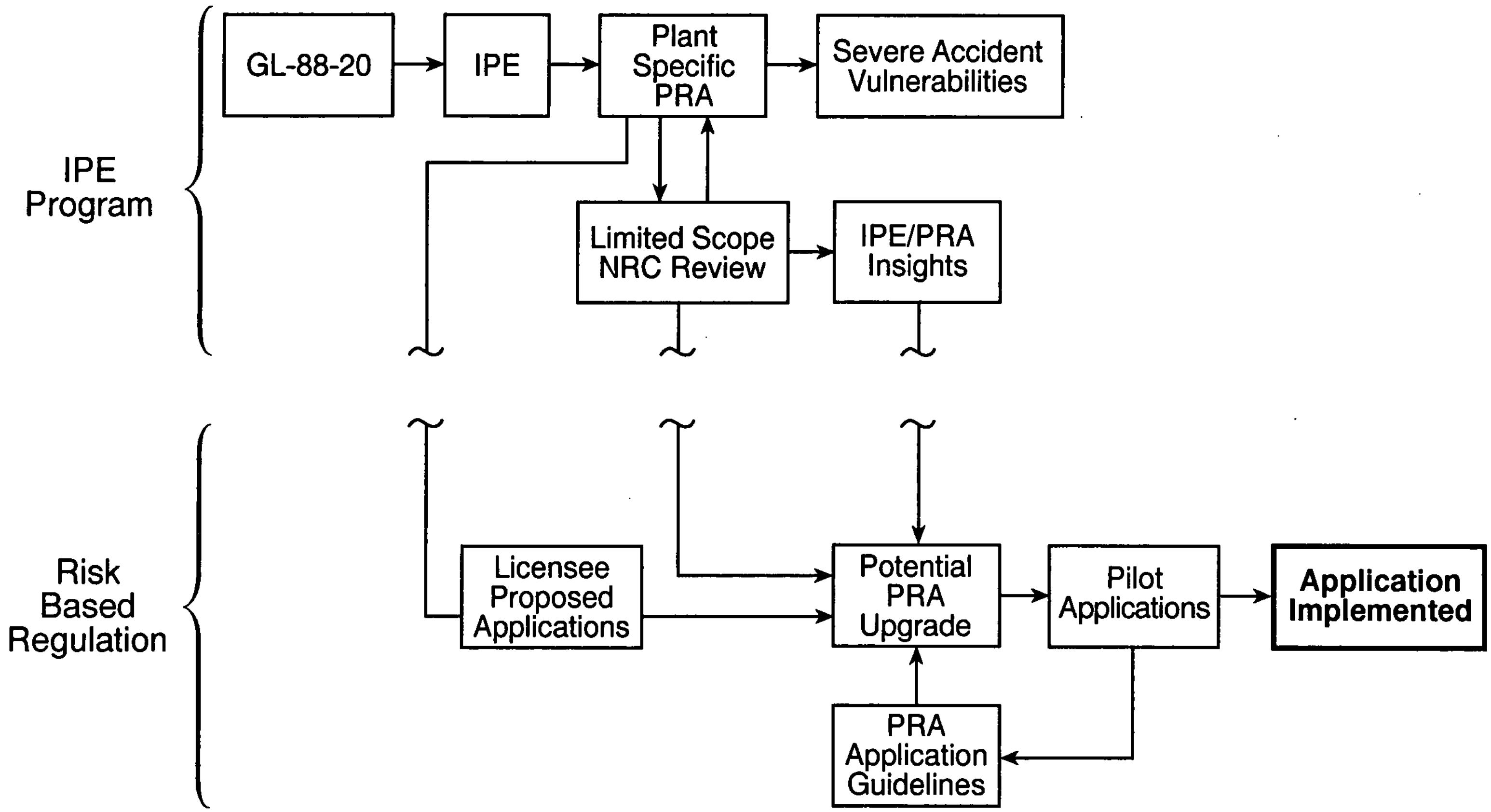
IPEEE Submittal Reviews:

- 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 ~ 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 diffusionflame 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 uncovery, 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