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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC

RISK ASSESSMENT

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MEETING

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FRIDAY,

JUNE 22, 2001

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ROCKVILLE, MARYLAND

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The subcommittee meeting was held at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. George E. Apostolakis, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

GEORGE E. APOSTOLAKIS	Chairman
MARIO V. BONACA	Vice Chairman
THOMAS S. KRESS	Member

COMMITTEE MEMBERS PRESENT: (cont'd)

GRAHAM M. LEITCH	Member
DANA A. POWERS	Member
WILLIAM J. SHACK	Member
ROBERT UHRIG	Member

ACRS STAFF PRESENT:

MICHAEL T. MARKLEY

I N D E X

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

(8:30 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Reliability and Probabilistic Risk Assessment.

I am George Apostolakis, Chairman of the Subcommittee on Reliability and PRA. Subcommittee members in attendance are Mario Bonaca, Tom Kress, Graham Leitch, Dana Powers, William Shack, and Robert Uhrig.

The purpose of this meeting is to discuss the staff's draft Individual Plant Examination for External Events insights report, draft NUREG-1742. The subcommittee will gather information, analyze the relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full committee.

Michael T. Markley is the cognizant ACRS staff engineer for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on May 23, 2001.

A transcript of the meeting is being kept and will be made available as stated in the Federal

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

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

We will now proceed with the meeting, and I call upon Mr. Alan Rubin of the Office of Research to begin. Alan, welcome.

MR. RUBIN: Good morning. Thank you.

Good morning, and thank you, Professor Apostolakis, members of the subcommittee. My name is Alan Rubin. I have been the project manager for the IPEEE program for quite a number of years, and I am here to present introductory comments.

There are other members of the IPEEE team who are with us this morning, including Brad Hardin and John Ridgely of the staff, who you will hear from later today, John Lehner from Brookhaven National Laboratories, and Steve Nowlen from Sandia National Laboratories. I just want to correct a typo I think on the agenda for that. Steve told me this morning he is not with Brookhaven.

(Laughter.)

By the way, there are quite a large number

of other participants in the program, including contractors, the staff in both Research and NRR, others, some of whom are present in the audience this morning. So I just want to acknowledge the contributions that many people have made to this program over the years.

The outline of today's meeting -- I will give introductory comments that will include some of the background on the IPEEE program, so that we're all talking to the same base of the objectives of the IPEEE program. I'll discuss a little bit of what took place in the reviews of the submittals, the process that the staff went through in reviewing licensees' IPEEE analyses. I will discuss an overview of what's included in the draft NUREG-1742, the insights report.

The second presentation will be on the seismic perspectives by John Lehner, then probably followed by the IPEEE fire perspectives given by Steve Nowlen. After lunch Brad Hardin will discuss the high winds, floods, and other external events aspects of the IPEEE program. John Ridgely will then discuss the resolution of IPEEE-related generic issues, generic safety issues, and unresolved safety issues.

I will then conclude the program with a discussion of some examples of how the IPEEE

information has been and may be used, and then give some overall conclusions and observations.

We would like to -- the staff would like to get a letter, if the Advisory Committee feels it appropriate, on the IPEEE program. We'll leave it up to you.

It might be helpful to us if we can get some perspectives on the committee's views and whether the -- if there's a feeling that the program has met the intent of the objective of the IPEEE program, perhaps some comments on the uses of IPEEE information itself. But it's really up to the deliberations of the subcommittee and the committee.

MEMBER POWERS: It seems to me that the objectives that the agency had in asking for the IPEEE effort were sufficiently qualitative, that there's a good chance that the effort met that. There may be some plants that are exceptions to that, but as a general rule it looks like it's a pretty easy set of requirements to meet.

There is another objective that I think we ought to have for the insights report itself, and that's to develop some intuition and understanding on the risks associated with external events for the agency's own thinking about risk-informed regulation.

And I wondered if you had set any objectives and had any -- you said you were going to give examples on how it might be used, but do you have any aspirations for what would be achieved by this effort in order to develop that agency's understanding of risk associated with these events?

MR. RUBIN: Well, let me -- let me answer that question when I get to the examples. But, basically, I think I agree with you that the -- at least from our view we think that the objectives of the IPEEE program has been met for all plants.

In terms of the uses of the information, it has been and is being used, from what I've seen, I think in an appropriate fashion. Just very briefly, to use, in my view, the quantitative estimates of core damage frequencies as a measure of a plant's risk, I would view that with a little bit of maybe not -- "skepticism" isn't the right word, but I'd look at that with a -- see what kind of analysis the licensee has done and what kind of a review and perspectives the staff has given in our staff evaluation report and technical evaluation reports.

So there's a lot of insights, I think, that are available if one wants to know some plant-specific information, both -- that's included in the

licensee submittals, but that's only a piece of the picture. I think it's very important to also look at what the staff has written in our staff evaluation report and that it include in the technical evaluation reports for each submittal -- to discuss the strengths and the weaknesses of what we see is in the submittals.

And although we have concluded that each submittal has met the intent of the IPEEE program, there clearly are, I'd say, differences in the approaches that licensees have taken. And those insights are included in individual technical and staff evaluation reports.

It was not possible to bring all of those specific -- plant-specific insights into one document which we call the IPEEE insights report. But I just wanted to make that point.

And I think, Dana, when I go through the applications later this afternoon in my concluding statements we can discuss this further, if that's okay with you.

CHAIRMAN APOSTOLAKIS: Now, regarding the IPEs, since you mentioned that you would like to have a letter, we wrote two letters on the IPEEEs. one was on the use of individual plant examinations in the

regulatory process, and the other on the potential use of IPE results to compare the risk of the current population or plants with the safety goals. That was five years ago.

I guess you are asking us to write a letter similar to the first one, the use of the IPEEE now in the regulatory process --

MR. RUBIN: Yes.

CHAIRMAN APOSTOLAKIS: -- because we commented also on the quality.

MR. RUBIN: Yes. I think the first one rather than the latter.

CHAIRMAN APOSTOLAKIS: The first one.

MR. RUBIN: Yes.

CHAIRMAN APOSTOLAKIS: This.

MR. RUBIN: Okay. Some of the background, to be sure we're all up to speed a little bit. The Generic Letter 88-20, Supplement 4, which was the IPEEE request for licensees to do IPEEE analysis and submit that information to the NRC, to identify plant-specific vulnerabilities to severe accidents for external events. That letter was issued in June 1991. Gosh, and here we are in June 2001 saying that the program is basically done.

At the same time the Generic Letter went

out, the staff issued a NUREG report, NUREG-1407, that included procedural and submittal guidance for licensees to conduct their IPEEE analyses. And also, in September 1995, there was a Supplement 5 to Generic Letter 88-20 that was issued that provided additional guidance and clarification on the seismic -- the scope of the seismic analysis for the IPEEEs.

I think we are all familiar with the external events that are included in the IPEEE program. Clearly, seismic events; fires; you will hear the term HFO, which stands for high winds, including tornadoes and hurricanes; floods, which is external floods; and the O in HFO stands for other, which covers transportation, nearby facility accidents, and other plant-specific or unique types of external events.

CHAIRMAN APOSTOLAKIS: I'm curious. When you issue a letter, a generic letter, do you give a deadline to the licensees, or sometimes you do, sometimes you don't?

MR. RUBIN: There was -- I think it was three years. There was a number of years to respond.

CHAIRMAN APOSTOLAKIS: So why is it 10 years, then?

MR. RUBIN: Well, by the time we got the

licensees' submittals, that was I would say probably at least a three- to five- or six-year timeframe. There were extensions, not everybody submitted at the same time, we couldn't -- you know, we don't have the resources to review them all in parallel.

CHAIRMAN APOSTOLAKIS: I see.

MR. RUBIN: We had some -- at least two dozen -- I'll get into this later -- Senior Review Board meetings to review the licensees' submittals. We've had at least one round and often two rounds of requests for additional information.

Writing the technical and staff evaluation reports is -- going through each plant review is probably about a two-year process from the time we start to writing the SER, roughly.

CHAIRMAN APOSTOLAKIS: Good.

MR. RUBIN: Okay. And 10 years flies by when you're having fun.

The status of the program. In January 1988, the staff provided a preliminary IPEEE insights report to the Commission. At that time, the report was based on the review -- I should say the preliminary review about one-third of the submittals. There were 70 IPEEE submittals in total covering all of the operating reactors in the U.S.

At that time, following that preliminary insights report, I had given FIVE presentations to various ACRS subcommittees and the full committee on various aspects of the program, fire aspects, seismic, HFO aspects. And here we are back again. Now the program is basically completed.

We have completed reviews for all 70 submittals. One plant, Haddam Neck, has shut down. So what we actually did, we issued 69 staff evaluation reports. Included in those staff evaluation reports, as I said earlier, are technical evaluation reports which contain a lot of useful information on plant-specific issues and strengths and weaknesses.

You have in front of you -- it was passed out and was issued in April 2001 -- draft NUREG-1742, which is titled "Perspectives Gained from the IPEEE Program," and that was issued for public comment. It has been given a very wide distribution. We have distributed about 500 hard copies, including e-mail distribution and announcements on the -- by e-mail, on the website, in the Federal Register notice.

Copies have been sent to all utilities, to various stakeholders, NRC staff, and others. The comment period ends on July 31st, 2001. I should say as of this date we have not received any public

comments yet, but that's not surprising. Usually when there's a deadline you try to get them to get comments at the last minute.

And our schedule was to issue the final NUREG-1742 in October 2001, taking into account public comments.

MEMBER LEITCH: Changes in procedures, and what not, made by the utilities as a result of this study, changes there were -- a number of utilities made various changes to procedures, in some cases hardware. Were those changes voluntary on the part of the utility?

MR. RUBIN: Yes.

MEMBER LEITCH: And it seems to me that some of the insights here could be -- other utilities could benefit from -- if Utility A made certain changes, Utility B may have the same situation and not have made those changes. This is just distributed to the utilities and hope that they will see what has been done here and try to apply it to their particular situation?

MR. RUBIN: The candidate -- there's nothing that the NRC is requiring or focusing on that. But I was going to get to it -- in Volume 2 of the draft report NUREG-1742, our plant-specific

information, the plant-specific tables, and the details, the types of improvements that each utility made.

One of the things consciously we tried to do, with staff and the Senior Review Board in reviewing the submittals, is not just on improvements, but where there are similar plants why there were differences. You know, why does one plant come up with a certain area that is a large contributor to risk and another one doesn't? Or another plant may have analyzed certain aspects of the IPEEEs differently, and we focused on that significantly.

So, I mean, in terms of what a licensee chooses to do, the improvements are voluntary. The Generic Letter itself is not a requirement. The Generic Letter is a request.

VICE CHAIRMAN BONACA: But going on the same issue, for example, in the fire area there were only three utilities, I believe, that had identifiable vulnerabilities.

MR. RUBIN: Yes. Two utilities, three units, yes, correct.

VICE CHAIRMAN BONACA: And one of them identifiable vulnerabilities in the turbine building, if I remember, that were significant. And there were

changes made to address those problems.

That plant has a number of sister plants with identified vulnerabilities. There were also some vulnerabilities tied to the design -- safety cables coming through the turbine building area in locations. Did you go back and check about sister plants to see if they had the same configuration concern or just simply was left to -- unaddressed? I mean --

MR. RUBIN: Well, we'll get into the vulnerabilities later on. But just let me briefly say of those two -- three units, okay, two reactors at one site, and one at another site, the first one was Quad Cities, which we have -- I have talked about to this committee before.

That first analysis that the utility did, they went -- the licensee went back and redid their IPEEE, the fire analysis, in its entirety. There was a lot of visibility. There were a lot of discussions with the staff. There were a lot of fire inspections. There was quite a host of activities, both at the utility and at the staff when this fire issue came up several years ago.

The licensee revised their analysis. We went out and did a site audit -- the staff and our contractors -- of the revised analysis. We walked

around the plant. We went to see what they did. And we felt they did a very good job, in fact. Their first analysis was very, very conservative, I would say. That's when they came up with the fire vulnerability. There was a core damage frequency of five times 10^{-3} just from fires. And that was a turbine building fire.

What we then -- we looked at very carefully other plants that -- whether they even looked at or discussed whether the cables -- safety cables running through the turbine building. And effectively as a result of our reviews, we questioned a licensee that did not identify a vulnerability in their turbine building, and as a result of the staff questions they discovered one and made changes.

VICE CHAIRMAN BONACA: Okay. So --

MR. RUBIN: So that's sort of a short summary of those vulnerability issues.

I'm sorry if I'm stealing your thunder, Steve, but the question came up.

VICE CHAIRMAN BONACA: No. It's -- I mean, understanding what the staff did with the information regarding other licensees.

MR. RUBIN: And by the way, that is an issue -- turbine building fires, that you brought up,

is a part of the aspects of the fire risk research program also as well.

Let me just set the stage. The objectives of the IPEEE program -- and Dana mentioned earlier they seemed like kind of -- I don't know if a "low bar" is correct, but they are not quantitative objectives. Let me just read them.

These were straight out of NUREG -- the Generic Letter 88-20, and these objectives were all for licensees. There was to develop an appreciation of severe accident behavior for their plants. We hope they would understand the most likely severe accident sequences that could occur at their plants under full power operating conditions.

The licensees were expected to gain a qualitative understanding of the overall likelihood of core damage in fission product release. It was not quantitative CDF estimates that we were after. In many cases, we did get quantification of core damage frequencies.

And, lastly, and very importantly, I should say, licensees would voluntarily reduce, if necessary, the overall likelihood of core damage in fission product release when making modifications, and plant improvements, be it either hardware or

procedural improvements, that could help prevent or mitigate such severe accidents.

CHAIRMAN APOSTOLAKIS: I guess I have a little of a problem with the qualitative understanding of the likelihood. That means roughly what it is. That's what it means?

MR. RUBIN: It means we wanted them to understand what the dominant contributors were.

CHAIRMAN APOSTOLAKIS: It says "likelihood."

MR. RUBIN: Right. Correct.

CHAIRMAN APOSTOLAKIS: It's a little bit difficult to --

MR. RUBIN: Would you have liked a different term or --

CHAIRMAN APOSTOLAKIS: Somebody at one point asked a physicist to gain a qualitative understanding of the speed of light.

(Laughter.)

I don't know. Go ahead.

MEMBER KRESS: It's fast.

CHAIRMAN APOSTOLAKIS: What?

MEMBER KRESS: It's fast.

(Laughter.)

MEMBER POWERS: Very fast.

MEMBER KRESS: Okay. You're right.

MR. RUBIN: Let me talk a little bit about the IPEEE review process itself. After we received submittals from licensees, they were reviewed to determine whether the licensee met the intent of the Generic Letter. That was clearly focused on the four objectives that I discussed in the previous slide, see whether the licensees followed the guidance that was given in NUREG-1407, to see whether there were gaps or weaknesses, and that they did a thorough job in covering the different aspects of each of the areas of the IPEEE.

The review process itself started with initial screening reviews where we focused on the quality and completeness of the submittals. And a very important aspect --

MEMBER POWERS: When you use the -- focused on the quality, what does that mean?

MR. RUBIN: It means what we did not do, we did not try to validate or verify the quantitative results, go back and check calculations that were included in the analysis. We wanted to see if they were -- if they included the important aspects of the program, but we didn't go and do a quality assurance check.

MEMBER POWERS: You looked at the index to see if they touched on the right topics?

MR. RUBIN: Correct.

MEMBER POWERS: Okay.

MR. RUBIN: And certainly, when there was information that looked either inconsistent, we raised questions. If they did not, for example, use appropriate values, we raised questions, if we thought those could contribute to a better understanding of dominant contributors to risk. And you have several examples of those later on in --

MEMBER POWERS: I have to say that in the text itself where you have highlighted those areas where it goes -- the reviewers questioned this, and they went back, that was very helpful.

MR. RUBIN: Okay. Thank you.

Let me just give an example. I think examples help. But there was some generic guidance that industry had put out, fire PRA implementation guide that EPRI -- that staff had not reviewed. And we went through quite an extensive review process with industry on a generic basis to resolve those questions, and it resulted in some additional and improved guidance to utilities to respond to our RAIs.

An example is in the fire area on the use

of quantitative values now for heat release rates from cabinet fires, heat loss factors, and analysis of room heat-up calculations as a result of a fire. So I should -- you know, it was not that we didn't look at the quantitative information in the IPEEEs, but we didn't go back and doublecheck that, yes, they came up with the CDF estimates and we agreed with it.

I mentioned earlier we did also have a few plants, selected plants -- four, in fact -- where we had site audits. These were additional reviews that were beyond the screening analysis. For some plants which either had poorly documented analyses and the licensees asked us to come to their site, or there were various technical issues that were in the reviewer's mind.

One of these site visits was to Quad Cities as a result of their fire analysis. They had a very high core damage frequency estimate for fires. Just another example, we had a site visit to Susquehanna. They were on the other extreme. They had an extremely, extremely low core damage frequency estimate, on the order of 10^{-9} for fires.

MEMBER POWERS: So why can't we all just follow Susquehanna's lead? That sounds good to me.

MR. RUBIN: They did, as a result of our

visit at Susquehanna, revise their analysis. They came up with a couple orders of magnitude higher estimate of core damage frequency, still on the low side.

But we felt after our site audit that they had identified the dominant -- where the dominant areas were, and they actually made some procedural improvements there as a result of that. So we considered that a success.

I mentioned that there was a Senior Review Board, which was a very important part of our review process. The Senior Review Board was comprised of NRC staff and contractors. Many of them are here in the audience, and you will hear two presentations this afternoon.

In the seismic area, that included Mike Bohn of Sandia National Laboratory and T.Y. Chang of the staff, who is in the audience. In the fire area, it included Steve Nowlen from Sandia National Lab, who will hear from later, Ed Connell, who is sitting over here from NRR, and Nathan Siu from the Office of Research who is also in the audience.

And the high winds, floods, and other areas included Mike Bohn, also from Sandia, and Rob Kornasiewicz who has since retired.

But for a large part we had most of these reviewers over the entire extent of the review process which was very, very helpful, very useful. That provided both technical advice on the scope and consistency of the individual reviews, and, more importantly, helped to provide assurance that vulnerabilities weren't overlooked.

There were a lot of discussions back and forth in these Senior Review Board meetings, and there were at least two dozen of them over the course of the years focusing on RAIs and what were important issues and important questions to pursue with licensees.

VICE CHAIRMAN BONACA: Just going back just for a question on technical decisions. Does that mean if you had a surrogate element --

MR. RUBIN: In a seismic.

VICE CHAIRMAN BONACA: -- in a dominant -- yes, in seismic, for example, you didn't consider that a technical deficiency, did you?

MR. RUBIN: No, because that was a methodology that was approved. We considered that a weakness, that you would not be able to -- in that group of -- if the surrogate element came up to be a dominant contributor, you would not be able to identify what element that was at the plant.

But sometimes if the overall risk were low, even if the surrogate element is high, we felt it may not be worth pursuing -- may not be necessary to pursue. But it is pointed out so that in terms of, I'd say, uses or applications of the IPEEEs, for example, for risk-informed activities, if there is a licensee that comes in with a request in the seismic area, and that plant -- particular plant has a surrogate element as a dominant contributor, it might be hard, difficult, to determine, you know, should they get some relief from some aspects in the seismic area.

So that information is -- I felt was very important and very useful, and it is included in all of the technical evaluation reports, if that were the case. And, in fact, it is even included in Volume 2 of NUREG-1742, the dominant contributors, where there are surrogate elements.

VICE CHAIRMAN BONACA: But would that give you some kind of indication of the quality of the PRA?

MR. RUBIN: It was an accepted approach. I don't know if -- it was nice when the surrogate element did not come up to the dominant contributor, which was the case most of the time.

VICE CHAIRMAN BONACA: Okay.

MR. RUBIN: But we didn't require licensees to go back and redo an analysis of those.

Just to touch base on the NUREG report, the draft 1742. Volume 1 has the generic insights, generic types of information primarily, and Volume 2 is a plant-specific database -- I call it -- from the IPEEE program. The report itself describes the overall process and the findings in each of the major areas of the program.

It discusses identified vulnerabilities, includes information on the quantitative findings, such as the range of core damage frequency estimates and the dominant contributors to plant risk in each of the areas. It touches base and discusses the plant modifications and improvements that have been implemented or planned for each of the licensees.

It talks about the overall strengths and weaknesses. Each plant-specific TER discusses those. But in the insights reports also we discuss the overall strengths and weaknesses and the very general stance and the various methodologies that we used in terms of models and assumptions for the analyses.

An important area that you will hear about later is the resolution of the external event related generic and unresolved safety issues that were, I'd

say, a challenging part of the review process which we've included in the IPEEE program.

The plant-specific database I mentioned. The report talks about the success in meeting the intent and the objectives of the IPEEE program and includes examples which I will discuss later on this afternoon of the uses of IPEEE information by both industry and the NRC.

If there are no further questions, that completes my introductory comments, and we can continue on with the program, go into -- John Lehner will discuss the seismic reviews.

MR. LEHNER: Good morning. I'm John Lehner from Brookhaven National Laboratory, and I coordinated the effort at Brookhaven to review the seismic portion of the IPEEEs and collect the insights.

I have also listed there some of the other contributors of Brookhaven, the reviewers of the individual submittals. And I should also mention that the first 20 plants were actually reviewed by ERI, Energy Research Incorporated.

What I want to present is an introduction and background on previous seismic programs, how the IPEEE relates to those programs, and discuss the

vulnerabilities that were -- the way vulnerabilities were treated in the seismic portion of the IPEEEs and also discuss the improvements that occurred because of the seismic reviews -- I mean, the seismic reviews of the licensees.

Then I'll talk about some of the perspectives of the actual analyses, first discussing those elements which were common to the two types of analyses, and then go into the particular perspectives from the PRA analyses that were conducted, and then the seismic margin analyses that were conducted.

Finally, I'll make some comments about some of the perspectives on the methodologies used, and wind up with some conclusions.

Alan Rubin put up a slide that indicated the objectives of the IPEEE program, and this just summarizes the objectives of the insights program as it applies to the seismic portion. Basically, we wanted to look at the processes used and the findings that the licensees had when they conducted their analyses, look at the plant improvements that came out of the seismic portion of the IPEEE program, look at plant-specific design and operational features as they might relate to the site-specific seismic hazards, and describe the strengths and weaknesses of particular

methodologies, and, finally, also look at the extent to which the licensees met the intent of Supplement 4 to the Generic Letter.

Again, as was mentioned by Alan Rubin, the insights program did not attempt to validate the results of the licensees' submittals.

MEMBER KRESS: If one wanted to do that, how would you go about it?

MR. LEHNER: To validate the results of the submittals?

MEMBER KRESS: Yes.

MR. LEHNER: I think you'd need a more indepth review than these screening reviews that we've conducted, perhaps by duplicating selective calculations, things like that, which were not carried out in our screening review.

CHAIRMAN APOSTOLAKIS: How would you validate the fragility curves?

MR. LEHNER: Well, I mean, there's obviously a lot of uncertainty in the fragility estimates. And, of course, for the IPEEE program, the NUREG-1407 allowed the use of a mean fragility curve as well as a mean hazard curve. So I think in most PRA applications for the IPEEE the licensees basically developed point estimates by using these mean curves.

I think some of them had previously existing PRAs where you probably had a more -- carry along more uncertainty, let's say. But for the IPEEEs, they really use -- they were allowed to use the mean fragility curve.

MEMBER KRESS: How do you feel about technical justification for that?

MR. LEHNER: For the use of the mean fragility curve?

MEMBER KRESS: Yes, for mean fragility and mean hazards, and combining the two to get a --

MR. LEHNER: Well, I mean, it -- I think for achieving the objectives of the IPEEE program, I think it's a valid approach. I think you have to --

MEMBER POWERS: Your text seems to be fairly critical. I mean, it says -- I quote, "And the use of simplified fragilities may have obscured findings related to dominant contributors to seismic."

MR. LEHNER: Well, I think that refers to the fact that some of the licensees -- well, some of the analyses, the assumptions that were made for the uncertainty and getting the -- I mean, you still have to assume a combined beta value and --

MEMBER POWERS: Combined beta value or not, this seems to call into question that Mr. Rubin

said, that the study satisfied the objectives of the IPEEE effort.

MR. RUBIN: Let me just add one thing. These were instances in our reviews of individual plants where the staff had asked for licensees to submit examples of their calculations and analyses, because we wanted to get some confidence if we had some questions on a particular plant, where the reviews might have been sort of on the margin, the kinds of analyses and we did look at those.

We didn't validate the results. We actually got their calculations and looked at that as part of the review, not across the board for each plant, but for some selected plants.

MEMBER POWERS: Well, I thought one of the objectives was to understand what the dominant contributors to the various hazards were. And yet here it says that using these simplified approaches to fragility may have obscured findings related to the dominant contributors to seismic CDF.

I mean, it seems to say that they didn't do it. Maybe I'm misreading the sentence, but it seems to say these things didn't satisfy the objective of the IPEEE.

CHAIRMAN APOSTOLAKIS: What page is that

on?

MEMBER POWERS: You can find it in a couple of places, George. But, in particular, on page 20, second bullet from the bottom.

MR. LEHNER: I think, you know, it depends how you interpret that statement. The "may have obscured" I think is not meant to say that it had not necessarily met the objective but that --

MEMBER POWERS: It's plain language. I mean, "may not have met," I mean, you can cast it any way you want to. Either it did or it didn't. And this says it didn't.

CHAIRMAN APOSTOLAKIS: Well?

MR. LEHNER: Well, I mean, the -- given the limited objective of the Generic Letter, perhaps that is too strong a statement. If you feel that that's the -- that's what it says, then that's --

VICE CHAIRMAN BONACA: Well, let me just say that that was an issue I didn't raise. But combined with the issue of the surrogate --

MR. LEHNER: Right.

VICE CHAIRMAN BONACA: -- in some cases being the dominant, etcetera, etcetera, there are a lot of almost disclaimers within the text of this NUREG as to the adequacy of any conclusions.

I mean, for example, when you compare as a timeline CDF, due to seismic for plants, you get to the conclusion that there hasn't -- you know, that seems as if the programs have improved the older plants such that -- that's rich because we know that for the newer plants, really, they were not evaluated for the true strength that they have. I mean, there were some limits that they used to perform the analyses.

So I'm only saying that to reinforce what Dana said, just there are a lot of disclaimers to the text that gives you a sense of, well, this is very, very soft.

MR. LEHNER: Well, I think the disclaimers were put in there to ensure that if the -- these results were used for other licensing issues that there are a lot of caveats to be observed here.

That's the reason for the disclaimers, not to leave the impression that the reviews that were conducted to see if they met the Generic Letter concluded that these analyses were then validated for licensing issues. So I think that's why you have the disclaimers.

VICE CHAIRMAN BONACA: And the text correctly identifies the methodological issues,

page 244, you know. But one is -- there is a good evaluation there, there is a good description, but one is left with questions regarding the conclusions being drawn from figures and tables, and so on.

MEMBER POWERS: Are we going to discuss more on fragilities? Is this the appropriate time to discuss more on fragilities?

MR. LEHNER: It probably is, yes.

MEMBER POWERS: There's this provocative thing that says, "UHS shapes for component fragilities calculated appear uncharacteristic when compared to conventional spectrum shapes derived from observed earthquakes." Point number 1. Point number 2, "As a result, seismic analyses using UHS spectra resulted in significant reduction in seismic demand as compared to corresponding design basis calculations."

Well, I can certainly understand why the design basis calculations might have a greater demand, but it -- I mean, when it says that the UHS shapes for component facilities are uncharacteristic, what are you telling me? These are some figments of somebody's imagination?

MR. LEHNER: Well, my understanding is that I guess a problem there is that for the eastern U.S. -- this is only true of the eastern U.S. plants.

I mean, the western U.S. plants have UHSs that seems appropriate. But perhaps because of the lack of earthquake data the -- that's available for the eastern U.S. --

MEMBER POWERS: It says it is making the comparison with observed earthquakes. Okay? I mean, that's what's interesting about the statement. It says you've got a fragility curve, has a spectrum that's uncharacteristic -- that's different from what you observe for earthquakes. I would assume that that would be a fatal flaw. Apparently not.

MR. LEHNER: Well, our reviews did not -- we didn't go back and -- we didn't have the ability to go back and see how these UHS spectra were established by the plants.

MEMBER POWERS: If somebody uses something that doesn't match well with experimental data, I mean, it doesn't strike me that that is maybe the best possible analytic technique.

MR. LEHNER: Well, I would agree with you.

MEMBER POWERS: Right. It doesn't go without passing. You said something here about that.

MR. LEHNER: Right. I think that's one of the methodological issues that we've focused on.

MEMBER POWERS: Yes, I think there is a

problem.

CHAIRMAN APOSTOLAKIS: Well, is this appropriate to ask, about the methodological issues?

MR. LEHNER: I have a slide.

CHAIRMAN APOSTOLAKIS: You have a slide.

MR. LEHNER: Yes. Well, just by way of background, this slide just discusses some of the regulatory bases for seismic designs of nuclear powerplants. 10 CFR Part 20, Appendix A, General Design Criteria 2, talks about protection against natural phenomena. Obviously, earthquakes is one of those.

The idea of a safe shutdown earthquake is in Appendix A of 10 CFR Part 100. And, of course, the NRC has issued a standard review plan with many updates and numerous regulatory guides that have been issued on seismic issues as this area has evolved.

It's worthwhile mentioning some of the seismic programs in the past that sort of led up to the IPEEE program. The systematic evaluation program recognized that some of the earlier plants had been designed before seismic design criteria had really matured, so that went back and looked at some of those plants.

Bulletin 80-11 looked at specifically

masonry and block wall issues that applied to -- in nuclear plants. Then, the Charleston earthquake issue or the eastern U.S. seismicity issue of course raised the point that the U.S. Geological Survey informed the NRC that there may be higher seismicity in the eastern -- in some of the eastern U.S. sites than originally thought.

And this led to the development of hazard curves by Lawrence Livermore Laboratory and also by EPRI for the various nuclear plant sites in the eastern U.S. And these hazard curves were then used in the IPEEE for those plants that did seismic PRAs.

MEMBER KRESS: My understanding is is they really all use the EPRI curves.

MR. LEHNER: They actually used both. I think two plants actually only used the Livermore curves, the revised Livermore curves. As you know, the Livermore curves were then later revised in I think '94. But most plants used the EPRI curves as their base case, and then used the Livermore curves as a sensitivity.

And they were asking -- I think NUREG-1407 actually asked that both sets of hazard curves would be used. And it turned out, as I'll talk about later on, that it did not make a significant difference in

the core damage frequency or in the dominant contributors.

MEMBER KRESS: That raises a question of justification of using the LLNL curves as a sensitivity then. Is that a justified use of them? Can you technically justify that as a use for sensitivity? I mean, why stop there, is what I'm saying, in terms of sensitivity. How do we know they balance the uncertainty some way?

MR. LEHNER: Well, no, I mean, as I said, the -- you know, the guidance in NUREG-1407 allowed the use of mean fragility and mean hazard curves and only asked for a use of the -- of both the EPRI and Livermore hazard analyses. I don't claim that it's a comprehensive uncertainty analysis, certainly.

MEMBER KRESS: What's bothering me is I'm afraid people are going to go back and misuse that as an uncertainty distribution.

CHAIRMAN APOSTOLAKIS: Which one? This? The Livermore curves do have uncertainty in them. They present families of curves.

MEMBER KRESS: I know. But they use the mean.

CHAIRMAN APOSTOLAKIS: Oh, they use the mean.

MEMBER KRESS: Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER KRESS: And I'm afraid that's going to be misused as an uncertainty.

CHAIRMAN APOSTOLAKIS: Oh, all right. All right.

MEMBER KRESS: When, really, you ought to go to the full uncertainty in the Livermore curves and propagate it through. But --

CHAIRMAN APOSTOLAKIS: But that wouldn't be an IPEEE, then. I mean, that's a major work, piece of work to do that. I mean, you are doing full scope --

MEMBER KRESS: What I'm worried about is misuse of the IPEEE results later on.

CHAIRMAN APOSTOLAKIS: You may think that you have a bound when, in fact, you don't.

MEMBER KRESS: Yes.

MR. LEHNER: I agree with you that the -- using the -- both sets of curves is simply a -- you know, it's an interesting comparison, but it doesn't --

MEMBER KRESS: Well, it doesn't make much difference, it doesn't seem like --

MR. LEHNER: Right.

MEMBER KRESS: -- like you said, except for one plant I think it was --

MR. LEHNER: Yes.

MEMBER KRESS: -- which surprised me. Do you know why that one plant made such a big difference?

MR. LEHNER: Actually, I don't, no. I mean, I think -- are you talking about the Seabrook?

MEMBER KRESS: Yes, I think it was Seabrook.

MR. LEHNER: There was like an order of magnitude difference --

MEMBER KRESS: An order of magnitude difference.

MR. LEHNER: -- in the CDF, yes. Yes. Unfortunately, Seabrook was not -- well, we at Brookhaven did not review Seabrook in detail, so we're -- I'm not sure why that was.

The other seismic program, of course, is the USI A-46 program, which looked at the seismic adequacy of electrical and mechanical equipment in plants. And that program was actually coordinated with the IPEEE program in many plants, and the procedures there developed by the seismic qualification utility group, the GIP, the generic

implementation procedures for seismic verification of equipment, was also used in the IPEEE walkdowns quite a bit.

Then, of course, the A-46 was a licensing program, whereas the IPEEE program is not. But the IPEEE program then, as I said, was coordinated with A-46. And, of course, under A-46 you also had the A-17, which was the spatial interaction issue, and the seismic capability of above-ground tanks, A-40.

Also subsumed in the IPEEE program were the external event part of A-45 and the Generic Issue 131 for the in-core flux mapping system applicable for Westinghouse plants. You'll hear more about the USIs and GSIs in this afternoon's presentation.

CHAIRMAN APOSTOLAKIS: Now, let me understand. Maybe you said it and I missed it. Important seismic-related programs undertaken by the NRC and industry -- what does that have to do with the IPEEE? These were undertaken as a result of the findings, or there were --

MR. LEHNER: No, no. These were things that led up to the IPEEE.

CHAIRMAN APOSTOLAKIS: Oh, way back.

MR. LEHNER: Yes. Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MR. LEHNER: And as I said, in other words, the hazard curves used in the IPEEE came out of the eastern U.S. seismicity issue. And the A-46 program -- a lot of plants -- for the A-46 program older plants had to evaluate their electrical and mechanical equipment, and they did it via a -- developing a HCLPF for the plant, which is similar to what they would do in a margin analysis.

They also developed this -- I'll talk about this a little bit more later on, but this success paths idea from EPRI. So when it came time for the IPEEE, a lot of plants that used margin analysis used the A-46 analysis as their basis and built a little bit on that to satisfy the IPEEE requirements.

MEMBER KRESS: Are you going to talk about the HCLPFs any later, or is somebody? The question I have is, we had one of our fellows do a study, and he concluded that you can correlate HCLPFs with actual effects on CDF. But if I look at the comparison of the plants that did both the HCLPF and a CDF, I don't see that correlation. And I was wondering if -- it raises a question in my mind, was our fellow wrong, or is there something wrong with the PRA or the HCLPF

analysis in the IPEEE?

MR. LEHNER: Well, I think there's a lot of --

MEMBER KRESS: It could be both, I guess.

MR. LEHNER: There's a lot of factors that enter into that. I mean, you -- if you derive the HCLPF from the PRA, then, I mean, there is -- I mean, in the margin analysis, most of the HCLPFs were derived by this CDFM method, the conservative deterministic failure method, whereas if you're deriving it from the PRAs then you are -- you are deriving it from the fragility curves.

And, I mean, ideally, if you did everything consistently you'd get similar results. But I think that -- I know the -- if you're talking about the figure that we have --

MEMBER KRESS: I forget which figure that was.

MR. LEHNER: Yes. I think you have to be careful about the assumptions that went into those calculations.

So the two analysis methods -- we've already touched on this -- that the guidance in NUREG-1407 allowed for were a margin analysis or a seismic PRA, and they were both, of course, ways of

comparing seismic demand versus seismic capacity of the important SSCs in the plant.

They both involved comprehensive walkdowns, and they were both ways of identifying plant vulnerabilities. And the 1407 guidance also called for at least a qualitative containment performance analysis.

The seismic PRA, as I said, 1407 allowed mean hazard curves or mean fragilities, but it also called for some enhancements in the sense that you had to look at relay chatter, soil liquefaction if it happened to be applicable at the site, and it also asked -- all this was optional -- that -- that plants with a SPRA calculator HCLPF, but most plants did not report a HCLPF that conducted the seismic PRA.

MEMBER POWERS: Let me ask you a question about soil liquefaction. Were there any constraints of what the licensee did there? I mean, do you have a standard for how to treat soil liquefaction displacements?

MR. LEHNER: No. I think that's one of the things that we mentioned, that there really doesn't seem to be an accepted methodology or accepted guidelines for, you know, what's an adequate soil analysis.

MEMBER POWERS: And so you -- whatever they did you just kind of had to accept?

MR. LEHNER: That's right.

MEMBER KRESS: Does that raise a need for -- if we actually wanted to put seismic PR contributions in the PRAs, is that a need that's unfilled?

MR. LEHNER: Well, I think some plants actually identified some problems in that area. Of course, you know, a -- I think the question is: what do you do about that? I mean, it's a very difficult problem to fix.

CHAIRMAN APOSTOLAKIS: Now, most plants I understand did margin analyses, didn't they?

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: Is there a big difference in terms of resources required between doing a seismic PRA and a seismic margin analysis?

MR. LEHNER: Yes, I believe so.

CHAIRMAN APOSTOLAKIS: I mean, but is there a big difference in the benefits as well? I mean, it seems to me the margin analysis, after you've done it, you've done it and it shows that you don't have any major problems, it's useless.

And you can't use any of that in

Regulatory Guide 1.174. Nothing. I mean, you don't have an estimate of the core damage frequency, so you save some money but you end up with nothing.

MR. LEHNER: Well, yes, that's an interesting point.

CHAIRMAN APOSTOLAKIS: I don't know why people prefer these things, because perhaps we don't insist that they use a complete PRA when they request other things so they could get away with it, because, you know, it's the same thing with FIVE on fires.

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: After you do it, unless you go on and do a PRA on the unscreened locations, you don't have results that can be used in the future. You just showed that you don't have vulnerabilities according to these rules.

MEMBER KRESS: One way to use those may be -- Bill Shack's take on this -- is if the margins analyses and the FIVE analyses shows you don't have to worry about fire or seismic, then you don't have to include them in your 1.174.

CHAIRMAN APOSTOLAKIS: Well, then, if that's the case, I think you need a much more detailed review than these guys were allowed to give those --

MEMBER POWERS: It seems to me, Tom, I

mean, this is like analyzing one sequence. You come out and you find out, well, that sequence is a 10 to the minus sequence, so I threw it away. And I, in fact, define my sequences so that they're all less than 10^{-6}, so I can throw them away, so I have zero risk from the plant. I mean --

MEMBER KRESS: You're exactly right. Especially if you're going to use importance measures, you've got to worry about that, too.

MEMBER POWERS: Yes. And that's what worries me here is that we're doing all of this categorization of equipment, and we're not getting any benefit out of this for the risk achievement or risk reduction worth with respect to seismic and fire and that categorization. And we'll never get it.

MEMBER KRESS: Yes. I was wondering if anybody would bring up the concept that just because it's relatively low contribution to the CDF, it may not be a relatively low contribution to the derivative, and that's what you're really finding in 1.174 is the derivative. And so, but anyway --

CHAIRMAN APOSTOLAKIS: Well, I think we should clarify this. Either we go back to 1.174 and say external events are not to be included, or we do a serious job here. I mean, you can't have it both

ways.

MEMBER KRESS: If the intent is to use this in 1.174, that might not be a --

CHAIRMAN APOSTOLAKIS: Well, 1.174 says the total CDF.

MEMBER KRESS: Oh, I know. But maybe 1.174 says don't use the IPEEEs. Go back and do a real seismic analysis.

MEMBER POWERS: Yes, but we never mean that.

CHAIRMAN APOSTOLAKIS: But we never mean that.

MEMBER POWERS: We say total CDF, but we never mean that, because we say that there's no risk whatsoever due to shutdown events. And now we're saying there's no risk due to seismic events. And pretty soon we'll get around to saying there's no risk due to fire events.

MEMBER KRESS: Might as well forget the internal events, too, then.

(Laughter.)

MEMBER POWERS: Might as well leave them out as well.

MR. LEHNER: I think some people actually have proposed a way of getting a pseudo-CDF, something

like an analysis.

CHAIRMAN APOSTOLAKIS: But why? I mean, I don't understand it. How much would it cost? Because remember now, these guys are building on what EPRI has done and Lawrence Livermore. They are not starting from scratch. They are just implementing something.

MR. LEHNER: And they also have the internal events PRA, too.

CHAIRMAN APOSTOLAKIS: And they have the internal events PRA. They have to do walkdowns anyway, no matter which approach they take. So it's a mystery to me. I mean, what -- is it because it will take time to try to understand what Livermore did? I don't understand this.

VICE CHAIRMAN BONACA: Well, I think in part it's the timeframe when the IPEEE came.

CHAIRMAN APOSTOLAKIS: It was 10 years.

VICE CHAIRMAN BONACA: Well, the utilities at that time were not allowed to use PRAs to justify changes as we see today, as 1.174 allows.

CHAIRMAN APOSTOLAKIS: That may very well be part of it, yes.

VICE CHAIRMAN BONACA: So that shift I think would justify on our part now to raise our

expectations, because since, you know, we have right now an STP that is coming, for example, with a significant initiative that is based on PRA insights, then that should be a counterpart in higher expectation. I don't think we are seeing it, you know, here -- because, again, it's the outcome of the program that started 10 years ago. Things have changed.

MEMBER POWERS: I think it's imperative to understand that there's been a change in mindset between when this Generic Letter was sent out --

CHAIRMAN APOSTOLAKIS: That's right.

MEMBER POWERS: -- and today that's a fairly significant change in mindset. And so those people that undertook things promptly after reading the letter really had no opportunity to respond to that change in mindset.

VICE CHAIRMAN BONACA: But wouldn't it be appropriate at this point for us to say they --

MEMBER POWERS: Well, it depends on whether they want to go to the risk-informed regulations or not. I mean, those are optional, so it's --

CHAIRMAN APOSTOLAKIS: I think we're going to end up with a standard thing that is going to say,

"These analyses will be upgraded as necessary in the future." I don't think anyone will go out and say, "Redo."

MEMBER KRESS: I think we did exactly the same thing in the IPE.

CHAIRMAN APOSTOLAKIS: Yes. And it's happening, by the way. It is happening. I mean, they are upgrading their IPE.

MEMBER POWERS: Yes. But the opposite is happening, too, George. People are coming in and saying, "Well, from the IPEEEs we get or" --

CHAIRMAN APOSTOLAKIS: And those guys do not find the staff very sympathetic, they don't think.

MEMBER POWERS: It's the staff that's doing it.

CHAIRMAN APOSTOLAKIS: Then we should not.

VICE CHAIRMAN BONACA: The main concern I have is what already Tom voiced on a specific issue. This document will be used in the future to draw a lot of conclusions, a lot of --

MEMBER POWERS: I think this document could be used to draw a number of conclusions, probably none of which are intended by you, the staff, or the industry.

VICE CHAIRMAN BONACA: Absolutely. And

those conclusions might be, you know, solidly incorrect, because it's just so limited.

CHAIRMAN APOSTOLAKIS: But it's really -- I mean, coming back to the original question, it's -- I'm a little bit puzzled by this tendency to do margins analysis. I mean, you could call this a screening analysis, which is a legitimate part of any PRA and then say, "Now, the remaining stuff I'll quantify."

MEMBER KRESS: That would be the right way to do it.

CHAIRMAN APOSTOLAKIS: That's the right way to do it.

MR. LEHNER: You know, I think my -- just my own opinion, but I think the fact that, as I mentioned earlier, that the A-46 program already involved doing a -- basically a margin analysis, it was very convenient for licensees to then do a similar, somewhat enhanced thing for the IPEEE.

VICE CHAIRMAN BONACA: You know, margins analysis was valuable for licensees in the early '80s when they were building plants, and they were asked to perform PRAs to demonstrate that the plant, as designed, had significant margin involved, what was in the design, and, therefore, no change had to be made.

That was the purpose of, really, margin analysis.

For this purpose, I totally agree with you that it doesn't give you the insights that you would want to have.

CHAIRMAN APOSTOLAKIS: Are you saying that anywhere?

MR. LEHNER: Well, we mention that --

CHAIRMAN APOSTOLAKIS: I mean, you have a Section 264, Seismic Evaluation Methods and Strengths and Weaknesses. Are you saying anywhere that the margins analyses are limited and that perhaps in the new regulatory environment they will not be too useful?

MR. LEHNER: No. We don't quite say that, no. I mean, we talk about what a -- you know, what an SPRA gives you and what a margin analysis gives you.

CHAIRMAN APOSTOLAKIS: Yes. But, again, you are placing them on the same level.

MEMBER SHACK: When you read what he says about the seismic PRAs, it does not inspire a whole lot of confidence.

(Laughter.)

CHAIRMAN APOSTOLAKIS: Like give me a characteristic sentence.

MEMBER SHACK: Well, page 254, "In some

cases, the use of simplified fragilities may have obscured findings related to dominant contributors to seismic CDF."

CHAIRMAN APOSTOLAKIS: Right.

MEMBER SHACK: You go back to 247. "Because of the correlation between the analyst's expertise and quality of the fragility calculations, guidelines or criteria may be made so that only analysts with sufficient qualifications will perform the fragility calculations in future seismic PRAs."

You know, some of the fragility analyses are good, and some of them aren't so good. It really is not --

MR. LEHNER: Actually, I think that's an interesting point, because I think we also mention in the report that overall the margin analyses were more consistent among each other. I think it's because -- and they're more comfortable with calculating -- making those kinds of calculations.

MEMBER POWERS: Well, you also have a guidance on how to do them, whereas there is no guidance --

MR. LEHNER: Right.

MEMBER POWERS: -- for how to do a seismic PRA.

CHAIRMAN APOSTOLAKIS: No. But, I mean, coming back to Bill's point --

MEMBER SHACK: Well, I mean, one of the conclusions I came to was roughly that -- that maybe I'm one of these guys doing these conservative assessments, because I didn't trust their ability to do something as --

(Laughter.)

MEMBER POWERS: Well, let me dissuade you of that, because it turns out that sometimes they follow the directions and sometimes they don't.

(Laughter.)

CHAIRMAN APOSTOLAKIS: Well, I don't think the degree of use of expert judgment in the actual PRA is that different from the margins. I mean, I'm sure you can repeat the same sentences by changing one or two words and make them applicable to do margins analysis.

MEMBER SHACK: No. And perhaps it comes back to -- at least it's consistent because there's a guidance document that sort of --

CHAIRMAN APOSTOLAKIS: Yes. But we are --

MEMBER SHACK: That doesn't make it right.

CHAIRMAN APOSTOLAKIS: What you're saying is we are producing consistently results we cannot

use.

MEMBER POWERS: Well, I question about the consistency, because I come back to this -- in some seismic margin analysis submittals licensees did not entirely follow the criteria for success path development or their submittal did not contain sufficient information to permit verification of the appropriate application of the criteria. I mean --

MR. RUBIN: May I make a comment, please?

MEMBER POWERS: -- this seems to be a very flexible world we live in here.

MR. RUBIN: Maybe a couple of comments. First of all, the point that was made that the Generic Letter came out 10 years ago, way before Reg. Guide 1.174, there was -- I don't even know if it was an inkling in somebody's eye, but risk-informed activities and the use of PRAs.

CHAIRMAN APOSTOLAKIS: In fact, we wouldn't even be using the words IPEs and IPEEEs.

MR. RUBIN: Right. So, I mean, that was not the intent of the IPEEE to use it for risk-informed activities. But I certainly agree, if someone has done a seismic margins analysis, it is going to be difficult to come up with, you know, a quantification to use in Reg. Guide 1.174.

Some of the comments that you are -- the subcommittee is making in terms of sentences seems to cast great doubts on the IPEEEs and their success. I think the intent we were trying to put forward in the report is that not everybody did an A job on their IPEEEs.

So we had to put some perspectives in this insight report to generalize or sort of characterize the flavor of the reviews. And what I said earlier is that you really need to go and look at the plant-specific staff evaluation reports and technical evaluation reports to see where these sentences apply.

I wouldn't broad-brush sentences that -- that these kinds of statements apply across the board to all of the IPEEEs. But we didn't want to also say that everything was so rosy and glory that it was, you know, the best thing we could ever imagine for all of the plants.

So that's -- I think you need to keep that in mind in looking at this report. It may be a hard thing to -- to write or to characterize. But if you've got some suggestions, I'd appreciate it. That's I think the help -- if it helps you in looking at the report, how we tried to put it together, that's just a comment.

MEMBER POWERS: My quotations of the language, not meant for criticism of the author's language. I think you guys were refreshingly honest in your presentation here.

MR. RUBIN: But I think it is taken a little bit out of context also, because you --

CHAIRMAN APOSTOLAKIS: Alan, let me ask you another question.

MR. RUBIN: Yes. Okay.

CHAIRMAN APOSTOLAKIS: Because I realize it's difficult to provide perspectives and comment on, you know --

MR. RUBIN: Yes. We're doing -- there are 69 perspectives in here, which we're not --

CHAIRMAN APOSTOLAKIS: Okay. But do you think that after this program -- your technical opinion and that of your group -- after this program, is there a unit out there that, in fact, might have a vulnerability in the sense that the seismic-induced failure would have a frequency of close to 10^{-4} or even greater? Is there a chance for that after you've done all of this?

MEMBER SHACK: Like Haddam Neck.

MEMBER POWERS: There is one.

MR. RUBIN: Haddam Neck is shut down, not

because of the IPEEEs by the way.

CHAIRMAN APOSTOLAKIS: But something that is hidden, that we don't know about. I mean, the level of review, the level of analysis is --

MR. RUBIN: I've been sitting in on all of these reviews. When I see the kinds of discussions, series of discussions that have taken place at our Senior Review Board meetings to go into these kinds of issues -- and, yes, there's a chance that something can slip through the cracks. We're doing a screening review.

But I'd say we're doing a very -- with the resources and the time, and there's nothing -- if there's a substantial amount of resources for each review -- I think we're doing a pretty good job to try and -- there's no zero probability, but I feel fairly confident that we have asked questions where there were lots of problems in initial reviews.

You know, if somebody just takes a submittal and uses that as the basis for characterizing a plant, I think they could be way off base without looking at the discussions on the RAIs and the responses that are in the staff's technical evaluation report.

So short response, I'd say the chance is

low but it's not zero. But don't ask me to quantify it.

CHAIRMAN APOSTOLAKIS: Can you give me a qualitative description of the margin?

(Laughter.)

MEMBER POWERS: A margin.

(Laughter.)

MR. RUBIN: Isn't low good enough?

(Laughter.)

Well, you know, we didn't see the 10^{-4}. Haddam Neck was on the high end. But we saw close to that. In fires we saw estimates of greater than 10^{-4}. For CDF estimates, in the low 10^{-4} range. We didn't, you know, consider or call that a vulnerability.

We felt that the licensee had made lots of improvements, even in the seismic analysis. Where they did seismic margins, the walkdowns led to lots of improvements. I mean, John hasn't gotten to that yet. But even though they can't quantify their PRA, they did make a lot of fixes based on the IPEEE.

MEMBER SHACK: Well, I sort of see it the other way. You know, I looked at the wide range of results you got and this sort of -- you know, does this sort of tell you that it's -- you know, you can't go any further with generic regulations?

Everything is now so plant-specific that you almost -- you know, you really do need a performance basis. If you don't like what they have, you somehow have to have a way to look at an individual plant and tell them, you know, to get their CDF number down.

MEMBER KRESS: Did I hear that right?

MR. RUBIN: I won't touch that one.

MEMBER KRESS: From Bill Shack?

(Laughter.)

MEMBER POWERS: These metallurgists are steeped in rigor. Just wait until we get to 50.46; you'll see rigor.

MEMBER KRESS: Okay.

(Laughter.)

MEMBER SHACK: Well, I didn't say these analyses were rigorous. I just said they show a lot of variability.

MEMBER POWERS: I didn't say the analyses were rigorous either. I just said metallurgists are steeped in rigor.

MR. RUBIN: Well, I think we do know that there is vulnerability among the design, and we expect variability among the PRA results. So that's not a surprise. Doesn't mean you can't, you know, come up

with generic regulations. But if you're doing something on risk insights, you really better look at the individual plant.

MEMBER LEITCH: Well, I'm left with the question that although you did not try to validate these results, when I look at the figure like that on page 232, I see two and a half orders of magnitude difference in the CDF results.

And I guess it seems to me that there could be at least three possible reasons for that. One is differences in methodology that was used, differences perhaps in identification of issues as a result of the walkdown, or perhaps just plain errors.

And I guess although you didn't really try to validate their results, as I understand, would you have looked at some of these outliers to see which of those might be contributing to these? In other words, are these really plant differences, or is it methodology and --

MR. LEHNER: Well, I think it's both. I mean, certainly, you know, plants have been designed to different criteria as seismic standards evolved. But methodology also plays a role, and I think one of the -- you know, one of the implicit outcomes of this whole individual plant examination and risk-informed

regulation is this idea of adopting standards to try and perhaps eliminate some of the variation in the -- in what's an acceptable methodology.

I believe the NS standard on seismic analysis is -- either has been released or is about to be released.

So in answer to your question, I think there is both elements, but I think the recognition that methodology played a role has also led to the idea of trying to put out some standards that would narrow those differences in methodology.

VICE CHAIRMAN BONACA: We just talked about Haddam Neck with 2.3 10^{-4} CDF from seismic. It's not surprising. But there are now plants of the same vintage still in operations, and they chose not to perform a PRA. So you have only a seismic margin analysis.

You know, there are issues left like that that come to mind all the time as I read that. What about that? Seismic margin seems to say that that's okay, and yet some of these plants they are part of the same vintage. Why would they be different from Haddam Neck? They wouldn't.

MR. LEHNER: They wouldn't. I mean -- well, I mean, you know, I don't want to categorically

say that they would have the same core damage frequency. But, yes, I mean, there were plants out there even when the margin analysis basically -- I mean, there are plants where the margin analysis did not give them a large margin over their design basis earthquake, as we'll get to later on.

So, certainly, plants seem to be up to the -- there was no plant that had a HCLPF that was below their design basis, but there were certainly plants whose HCLPFs were below the review level earthquake.

All right. So just to conclude with this slide here, basically two margin analyses, one developed by the NRC, which is an event tree/fault tree approach, and the other one by EPRI, which is the success path approach. And almost all licensees that did a margin analysis used the EPRI method. I think there were only two licensees that did an NRC seismic margin.

Now, the guidance in NUREG-1407 basically binned the plants into various analyses categories, and this was based on the seismic hazard associated with a plant site as well as, to some degree, the design of the plant.

Maybe it's easier to start out with a full scope seismic margin analysis where the SSCs will be

evaluated against a review level earthquake, which was basically 0.3 g for the eastern U.S. These plants had to do a detailed relay chatter evaluation, soil failure evaluation, and, of course, perform a walkdown -- a detailed seismic walkdown.

Most of the plants that did -- that were binned into the focused scope seismic margin category, here again, they had to evaluate their equipment against a review level earthquake. The relay evaluation was less rigorous in the sense that only relays that had been identified previously under the A-46 program as low ruggedness relays that were now in the IPEEE scope but not in the A-46 scope had to be examined.

And as far as the soil failures, these plants originally were asked to do a soil failure evaluation under Supplement 4. And so the ones that did their margin analysis early on did so, but most of the plants actually did not have to do a soil failure evaluation because Supplement 5, which was issued in the mid '90s, recognized the lower seismic hazard of the revised Livermore studies and eliminated soil failure evaluation from the scope of the focused scope seismic margin analysis.

And then there was also reduced scope

seismic margin for those plants which were in very low hazard areas. And here the plant basically did not have to evaluate against the review level earthquake, the 0.3 g earthquake, but basically had to evaluate against their design basis, their safe shutdown earthquake. So the safe shutdown earthquake became the review level earthquake in that sense.

And, of course, the plants in the western U.S. either had to do a seismic PRA, or the 1407 also let them do a 0.5 g review level earthquake margin analysis.

CHAIRMAN APOSTOLAKIS: You said that some were EPRI proposed and some NRC. From these, your scope of what -- which one is EPRI?

MR. LEHNER: Either one. You could use either methodology --

CHAIRMAN APOSTOLAKIS: To do any of these.

MR. LEHNER: -- to do any of these.

CHAIRMAN APOSTOLAKIS: Okay.

MR. LEHNER: Yes. As I said, only two plants use the NRC margin analysis. But the scope here could be accomplished using either one.

This next slide shows how NUREG-1407 binned the plants and what they actually did. in other words, on the left-hand side here, there were 10

plants that were binned in the reduced scope category, 49 in the focused scope, eight in the full scope, and four that had to do seismic PRAs.

As it turned out, many more plants did seismic PRAs. A lot of the focused scope plants did seismic PRAs, so we wound up with a total of 27 seismic PRAs out of the 71 submittals. One plant did actually both analyses, did both a margin analysis as well as a seismic PRA analysis.

A number of plants -- as you can see here, the shaded area sort of indicates the minimum. If they're in the shaded area they did something less than what was specified in 1407, and there were a few plants that in the reduced scope category sort of did a plant-specific analysis which was a variation on reduced scope.

And in the focused scope category there were a number of plants that felt that the Supplement 5 allowed them to actually do a reduced scope. And in those cases while the submittal was, let's say, less than adequate to --

CHAIRMAN APOSTOLAKIS: John, let me ask you something --

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: -- because I don't

quite follow. I look at the last column.

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: SPRA. And it says -- it has four numbers -- 1, 18, 4, and 4. The total is 27.

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: What does that mean?

MR. LEHNER: Okay. If you look at -- let's look at the second row, focused scope.

CHAIRMAN APOSTOLAKIS: Okay.

MR. LEHNER: Forty-nine plants were binned into the focused scope bin in 1407. So those 49 plants could have done a focused scope margin analysis and satisfied the requirements. It turns out that, of those 49, 29 actually did a focused scope, 18 did a PRA, and three did a reduced scope.

CHAIRMAN APOSTOLAKIS: But why, then, did they end up in the focused scope bin if they did the reduced scope?

MR. LEHNER: Well, that's what I was just explaining, that they -- I mean, the bins were set up ahead of the IPEEE process. The bins were the minimum requirements the plants had to fulfill in order to meet the intent of the IPEEE.

Most plants either chose to fulfill those minimum requirements or did more, like those 18 plants that did the PRA actually did more than they were required. In a few cases, plants did less than they were required, and those are the ones in the shaded area.

CHAIRMAN APOSTOLAKIS: And they still claim they did a focused scope?

MR. LEHNER: Well, they claimed that Supplement 5 gave them relief from focused scope and they could do a reduced scope, which was a questionable interpretation.

CHAIRMAN APOSTOLAKIS: Well, then, how did you decide to put a unit in the reduced scope bin or the focused scope bin? That --

MR. LEHNER: Oh. Because when they presented their submittals, their submittals --

CHAIRMAN APOSTOLAKIS: So they declared it.

MR. LEHNER: They declared themselves.

CHAIRMAN APOSTOLAKIS: Oh, I see.

MR. LEHNER: Yes, they declared themselves. They stated how they met the IPEEE.

CHAIRMAN APOSTOLAKIS: So 49 licensees declared they were doing the focused scope.

MR. LEHNER: No. Forty-nine licensees -- the guidance by the NRC said you 49 licensees have to do at least a focused scope.

CHAIRMAN APOSTOLAKIS: Hmmm?

MR. LEHNER: The left-hand column is the guidance by the NRC in NUREG-1407. It said you 49 licensees have to do at least --

CHAIRMAN APOSTOLAKIS: So you told them what to do.

MR. LEHNER: Yes.

MEMBER SHACK: Set a minimum.

MR. LEHNER: A minimum standard.

CHAIRMAN APOSTOLAKIS: For those 49.

MR. LEHNER: Yes. That was the minimum standard for those 49 plants.

CHAIRMAN APOSTOLAKIS: So you --

MEMBER SHACK: And then you guys went further.

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: So you told four licensees to do a seismic PRA.

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: But, in fact, 27 of them did it.

MR. LEHNER: Right. Exactly. So, you

see, it actually is -- it's actually a little bit -- I mean, if everybody did the minimum you'd only have four seismic PRAs out there.

CHAIRMAN APOSTOLAKIS: Anyway, I -- okay. But did you see a clear difference between the conclusions and insights that a seismic PRA offered versus one that is a reduced scope? I mean, is it clear that the licensee who did the seismic PRA benefitted more?

MR. LEHNER: Oh, yes, I think so. I mean, the seismic PRA would give you, you know, dominant contributors. A reduced scope basically -- you know, a reduced scope, the licensee did not even have to calculate a HCLPF for the plant. They basically just had to see that they met the review level earthquake. And the justification was that these were plants in a very low seismic hazard area.

CHAIRMAN APOSTOLAKIS: I'm sorry. Go ahead.

MR. LEHNER: Sure. I was saying that there is definitely, you know, greater benefit to the seismic PRA because the PRA gave the licensees better insights as to not just the core damage frequency but also the dominant contributors during a seismic event to core damage, whereas a reduced scope basically only

told them that their equipment was adequate for the design basis earthquake.

CHAIRMAN APOSTOLAKIS: Okay. You have a total of 21 viewgraphs and you are just completing number 7, which is one-third. And you have been talking for an hour.

(Laughter.)

MR. LEHNER: I'll try to speed it up here.

(Laughter.)

All right. In the seismic area, nobody really -- well, I shouldn't say nobody. The vulnerabilities -- it was left to the plant to define what constituted a vulnerability, and definitions varied quite a bit. Many plants -- most of them that did margin analysis did not define vulnerability but said they had none anyway. And a lot of plants avoided the term altogether.

In some cases, in the seismic area where they did identify vulnerabilities, the kinds of things that they identified were similar to what other plants called outliers or open issues or anomalies. So, you know, the bottom line is that the -- where vulnerabilities were identified they were -- it would be unfair to characterize those plants any differently than the ones that did not identify vulnerabilities.

Now, by the way, I think one reason that no serious vulnerabilities were identified was because of the fact of some of these other previous seismic programs, like A-46, where a lot of inadequacies have been addressed already and fixed. Be that as it may, even though very few licensees identified vulnerabilities, almost all licensees made some kind of fixes that related to outliers or open issues that they identified during their assessment.

And so a lot of improvements were made in the seismic area in response to their analysis. And this list -- some of those examples, they are basically improvements in the hardware area, in maintenance, housekeeping issues, or in procedures and training. Overall, 70 percent of the plants made some sort of improvements in response to their seismic analysis.

And you can see here the number of plants that reported this type of improvement. For those plants that had no IPEEE-related improvements, about half of them had already made improvements under the A-46 program and felt there were no further fixes needed under IPEEE. And then, you know, about 10 plants said that -- mainly the newer plants said that there were no additional fixes that they had to make.

MEMBER UHRIG: On the hardware, there were sort of three generations of seismic hardware over the years. Was this additional hardware coming in, or was it replacement with the more sophisticated hardware?

MR. LEHNER: I think in some cases it was replacement. For instance, in the relay area it made some replacements. But additional -- but mainly it was -- as indicated there, you know, strengthening anchorages, bolting things down, bolting things together, eliminating spatial interaction problems where one component -- a non-safety-related component could fail and fall onto a safety-related component, that sort of thing.

So it was not a large exchange of equipment. As a matter of fact, most of these improvements were low-cost improvements, you know, in spirit with the Generic Letter, really. They were low-cost improvements, but significant improvements, effective improvements.

MEMBER KRESS: How did they reinforce masonry walls?

MR. LEHNER: How did they reinforce masonry walls?

MEMBER POWERS: Steel and wire. That's the most common way to reinforce it.

MEMBER KRESS: Just build a frame in front -- on each side of it?

MEMBER POWERS: All the way around it.

MR. LEHNER: At least to -- yes, to prevent it from falling onto -- I mean, the masonry walls issue, again, was only an issue if the masonry wall would --

MEMBER KRESS: If it falls onto something.

MR. LEHNER: -- fall onto some vital piece of equipment. So if you could protect it --

MEMBER KRESS: I would almost think you'd have to have a framework to do it, rather than just --

MEMBER POWERS: Well, usually just some bars across it. Or weaken it on the other side, so it would fall in the other direction.

(Laughter.)

MR. LEHNER: All right. Let me quickly go through these elements that were common to all of the seismic IPEEEs. Screening was done both in the PRA area and in the seismic margin area.

The screening level -- for those people that did margin analysis, they basically used the review level earthquake, g level, as the screening level, and used the EPRI NP-6041 guidance. There are tables in there that allow you to screen out

components based on past experience.

In the PRAs, they also screened out in some cases based on the review level earthquake; in other cases, higher screening levels. And, in general, in many PRAs they screened out the majority of components. Obviously, that would reduce the amount of analysis that had to be done.

The walkdowns were really I think one of the most important benefits of the IPEEE program, especially for those plants that did a reduced scope analysis. It was really a walkdown that was the essential outcome of the IPEEE, where they looked at their SSCs, looked at capacity versus demand, and looked for outliers, and quite a few outliers were identified.

They checked anchorages, looked at spatial interaction concerns, identified those, and there were many -- I think most of the insights that the licensees gained came out of the walkdown process.

I'll talk about the dominant contributors and weak links a little later on. For relay evaluation, because the relays had been evaluated so thoroughly in the A-46 program, there were a few significant low ruggedness relays that were identified solely as a result of the IPEEE program.

The IPEEE program scope was a little bit bigger than the A-46 program, so there were more relays included under its scope. But those relays that were identified as low ruggedness usually proved to be not important for the safe shutdown of the plant.

MEMBER POWERS: I will say that in the documentation on this, where you discussed this is extremely confusing. What you've written up here is very clear.

MR. LEHNER: Okay.

MEMBER POWERS: You might want to change that language, because it took me forever to sort out what you actually meant by the words in here. That sentence is much better than the -- what you say -- things like chatter or vulnerable relays in selected success path circuitry that related only to the IPEEE did not have adverse consequences. And that made no sense to me. If it was a success path, it had to have adverse consequences. Now I think I understand better what you were saying.

MR. LEHNER: Yes. I understand what you're saying, but the key phrase there is "related only to the IPEEE."

MEMBER POWERS: Yes. That clause you say

has already been fixed --

MR. LEHNER: Okay.

MEMBER POWERS: -- is what you need in there.

MR. LEHNER: Right, right. Exactly.

Soil evaluation -- as I indicated before, those sites that were located on -- those plants that were located on soil sites did soil analyses for liquefaction and slope instability. They looked at stresses in buried piping. And as we discussed earlier, there is no general consensus on the best approach to look at liquefaction-induced soil displacement.

But some sites had identified this as a -- as -- actually, they identified it in their screening analyses -- or I should say in their first analyses, those sites that identified soil problems usually went back and took a closer look and managed to allay some of the concerns with their soil failure.

As far as non-seismic failures in human actions, in the PRAs these were, of course, included in the event trees and fault trees, because most licensees that used seismic PRAs adopted their internal events -- event trees and fault trees, and so they had human actions and non-seismic failures

included.

And for the human actions they used a wide variety of approaches to account for seismic stress. Usually they had a multiplier on the human failure rates that they used in their internal events, and then had some g-level beyond which the action was no longer considered credible.

MEMBER POWERS: I mean, it seems plausible what they did, but how do you -- how do you have any confidence that the multiplier or the scaling factor that you've used has any bearing on reality?

MR. LEHNER: Well, that's a difficult question. I mean, you know, it's hard to run a simulation of a seismic event.

MEMBER POWERS: Well, actually, it's probably pretty easy. We just don't do it.

MR. LEHNER: I think if you get the right stress levels, it's --

CHAIRMAN APOSTOLAKIS: That's a very important point. In fact, on page 225, the report says that no strong technical basis was provided for the values chosen, which is an accurate statement. But what is disturbing a little bit is that it was not identified -- this issue of human error probabilities was not identified anywhere else in the report as a

weakness of the methodology and as something that something needs to be done about.

I think the guys who wrote 264, Seismic Evaluation Methods and Strengths and Weaknesses, were seismic people. And they have no appreciation of the human error stuff; that's for somebody else. Yet we are talking about seismic PRAs here, so the whole thing is one thing. So to -- and the same thing applies to fires, by the way.

But to say this -- that somebody says -- and I multiplied by five because, you know, there were bad conditions, and everybody says okay, that doesn't make sense to me at all. And then --

MEMBER POWERS: Well, we accepted an STP for doing sensitivity studies.

CHAIRMAN APOSTOLAKIS: That's not the same thing.

(Laughter.)

But then what's even more perplexing is if you go to page 529, which deals with -- now you're going to tell me somebody else is going to do that, but this is for that somebody else -- IPEEE-related aspects of common cause failures related to human errors.

Okay. All of the 69 IPEEE submittals,

which excludes Haddam Neck, provided some treatment or discussion of non-seismic failures and human actions. Of the 69 submittals, 61 provided adequate information to resolve this issue -- this issue being part of Generic Safety Issue 172.

Two provided adequate information to partially resolve this issue, and six did not provide adequate information. And so what I would like to see is the details from one of the 61 submittals that provided adequate information using these non-sensical multipliers and to resolve a generic safety issue. How can that be?

On the one hand, we say that there is no strong basis for these numbers. And then we say 61 of 69 provided adequate information to resolve this issue. So maybe someone who will address the issue of the generic safety issue later will explain this? I'd like to see the details. I'm not really objecting to this. It's just that it sounds like it's inconsistent with the technical evaluation that went on before.

And, you know, if you look at -- I guess common cause failure and human error, if you look at page 525 where there's a figure, it's clear that common cause failure is an important element. So how did these 61 guys manage to resolve the generic safety

issue when the technical basis is not strong?

John, you can go on. Obviously, you're not going to -- you are not the one to answer the question.

But I -- you know, this is another case, like the one we were discussing earlier regarding total CDF. We say that human error is important; the agency should do something about it. And then people do these funny things, and we don't raise hell. And we just accept it, and, you know, well, what can you do? I mean --

MR. RUBIN: Can I --

CHAIRMAN APOSTOLAKIS: Yes.

MR. RUBIN: May I add a couple of points? In many of the seismic submittals in particular, in terms of human failure, human actions, the seismic event was over quickly, and the procedures that the licensees had in place were for operators in the control room, for the large part.

There were instances -- I can think of an example where a licensee was -- and we questioned this -- the licensee was going to take credit in a seismic fire interaction for going down into the plant and shutting a valve for hydrogen in the line for a seismic event. And we said, "Wait a minute. How can

they take credit for that?" And we pursued that further.

But for the large part, many of the actions were in the control room. They're not remote. The seismic event is over relatively quickly.

CHAIRMAN APOSTOLAKIS: But I --

MR. RUBIN: We need to clarify the report, I think.

CHAIRMAN APOSTOLAKIS: But I still would like to see one or two representative cases from the 61 licensees.

MR. RUBIN: We'll try to get you some this afternoon.

CHAIRMAN APOSTOLAKIS: That would be more convincing, I think. That would be an uncertainty analysis, sensitivity analysis. But perhaps the people who write the conclusions on seismic and fire should not be seismic and fire experts, because they have no appreciation for everything else.

Okay. You can't say in one place the numbers are arbitrary, and then when it comes to the conclusions you don't even mention it. I mean, I -- it seems to me based on what I read here, not on what Alan said, there is very strong evidence in this report that we really don't know how to quantify human

error -- period -- under these conditions. And we should say that.

Now, that doesn't necessarily mean that the IPEEEs are useless, because, you know, there may be situations like Alan just described one or two where, you know, that may not be the driving force. But it should be emphasized, because it -- this -- you know, anyway, I said enough.

MR. LEHNER: I think maybe what you're saying, it should be one of the items that's mentioned under some of the methodological issues.

CHAIRMAN APOSTOLAKIS: Yes. If some of the dominant sequences involve human error, yes, it should be. Even though it is not something that a fragility expert will do --

MR. LEHNER: Makes sense, yes.

CHAIRMAN APOSTOLAKIS: -- it's part of the methodology.

MR. LEHNER: Well, in the --

CHAIRMAN APOSTOLAKIS: When do you think it's a good place to stop? I don't want you to be there for two hours -- if we're going to take a break. I mean, in terms of your presentation. Don't ask other people.

MR. LEHNER: Well, let's see. Well,

actually, maybe after these -- maybe after these common elements would probably be --

CHAIRMAN APOSTOLAKIS: Okay. So the next one is SPRA results.

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: Okay. Fine.

MR. LEHNER: Now, just to mention regarding non-seismic failures and human actions, in the margin assessments, these were usually only qualitatively -- well, not usually, they were only qualitatively discussed. And sometimes we had to specifically ask in our RAIs about the human actions.

And the licensee basically then explained that -- about the location and timing of the human actions that were involved in the success paths, and those explanations were usually convincing that they had chosen success paths where human actions were well understood and were in the control room. And so I think this reinforces what Alan said earlier.

So in that sense, you know, the explanations in many cases that they furnished for the human actions involved in the success paths were reasonable.

Regarding seismic fire and seismic floods, seismic-induced fires were -- the submittals indicated

that the licensees had looked at seismically-initiated fires. They also looked at seismic actuation of the fire suppression system or a degradation of the fire suppression system from seismic events.

And a number of licensees had found some outliers in this area, and they felt that some of their significant plant improvements were revealed by looking at these issues. These were things like looking at hydrogen lines.

You know, they first looked at fire sources and then looked at the vulnerability of those sources, like oil tanks or hydrogen lines and how vulnerable these were and some of the improvements they made was to put added restraints on these things and furnish protection from having these items initiate fires due to the seismic event.

And, again, these came out of the walkdowns where, you know, they looked at these plant areas where there were fire sources and how vulnerable they were, and that was one of the big benefits from the walkdowns.

There were a few PRAs that actually looked at the seismic-induced fires and seismic-induced floods in their actual accident sequences, but most of them were addressed as minor walkdowns.

Regarding containment performance, most of the assessments only looked qualitatively at containment, looking at containment integrity, isolation, bypass. I mean, the guidance in NUREG-1407 was that they should look for containment failure modes, you know, unique to a seismic event that they would -- that would be different from things that they identified in the internal events PRA.

And there were a few seismic PRAs that actually did a Level 2, and, as indicated there, there were some -- the LERF frequencies identified in those PRAs varied from 10^{-7} to 1.6 10^{-5} per year.

And, finally, all of the IPEs, as required by NUREG-1407, conducted an independent peer review to ensure the overall quality of the submittal, and they listed the review members. And some of them even listed the questions that the review members had asked and their replies to those questions.

If there are no questions, I --

CHAIRMAN APOSTOLAKIS: Any questions from the members?

VICE CHAIRMAN BONACA: I just had a question about seismic fire and seismic flood. The text specifically states that a few of the evaluations included those kinds of consequences -- fire and

flood. Most of them did not.

MR. LEHNER: The PRAs.

VICE CHAIRMAN BONACA: Yes, the PRAs. Yes. In the PRAs that considered those, did they find those issues to be significant in risk?

MR. LEHNER: I don't think they showed up as dominant contributors.

VICE CHAIRMAN BONACA: Okay.

MR. LEHNER: I do not believe so. No, I don't believe so.

VICE CHAIRMAN BONACA: Okay. Thank you.

MEMBER SHACK: Typically, who was on these independent review -- peer review panels? I mean, other utilities, consultants, internal or --

MR. LEHNER: Usually, there were some outside consultants, plus some internal staff members who were not involved in the actual IPEEE.

MEMBER SHACK: But in all cases there would be somebody from outside, then.

MR. LEHNER: Yes. Yes.

CHAIRMAN APOSTOLAKIS: Any other comments?

Okay. According to the schedule, we'll reconvene at 10:45.

(Whereupon, the proceedings in the foregoing matter went off the record at

10:24 a.m. and went back on the record at 10:45 a.m.)

CHAIRMAN APOSTOLAKIS: Ready to start again, John?

MR. LEHNER: Yes. Turning now to the quantitative results from some of the seismic PRAs that were carried out, this viewgraph shows a histogram of the various CDFs.

Now, as indicated there in the parentheses, what's plotted here is the CDF values that were obtained with both the EPRI and the Livermore hazard data. In other words, many plants appear twice on this histogram. One was their EPRI CDF and one was their CDF based on the Livermore hazard data.

And, I mean, in general you can see that most of the CDFs fall between 10^{-6} and 10^{-4}, kind of the range that previous seismic PRAs have shown. Those three data points in the 10^{-4} to 10^{-3} range, two of those points are the Haddam Neck plant that, as we talked about earlier, has been shut down. And one of them is the Seabrook CDF with the Livermore hazard curve. But with the EPRI hazard curve it's -- the Seabrook plant is in the 10^{-5} range.

This next viewgraph just indicates the

comparison of the CDF based on EPRI versus Livermore for those plants that used both hazard analyses. And you can see that the difference, except for that one point which happens to be Seabrook where there is an order of magnitude difference in their CDF, the --

CHAIRMAN APOSTOLAKIS: I don't understand the figure. Can you make it horizontal? So what are we looking at their? Seismic CDF-based --

MR. LEHNER: We're plotting here --

CHAIRMAN APOSTOLAKIS: Maybe you can use the mobile microphone.

MEMBER POWERS: I mean, you do have it in your viewgraph.

CHAIRMAN APOSTOLAKIS: Yes. But he wants to stand up and discuss it. I mean, if he wants to.

MEMBER POWERS: Well, I mean, it's one CDF quantity as to another CDF. You compute the CDF with the one hazard curve, and then you compute it with the other, and you plot them one to one.

CHAIRMAN APOSTOLAKIS: I knew there was something simple about it.

(Laughter.)

And then the point tells us what? I mean, the 45-degree line, it means that --

MR. LEHNER: Well, if they were exactly

equal they would all fall on the 45-degree line, right? So this shows you the difference that the different hazard curves made. I mean, if we take any one point here, this is the value of the CDF that was based on the Livermore curve. And this is the value of the CDF based on the EPRI hazard results.

CHAIRMAN APOSTOLAKIS: Right.

MR. LEHNER: So as I said, if they were all -- if the results were all perfectly equal there, they would be along this line. As you can see, this is sort of the linear regression line through the results that there -- in most cases there was not a significant difference.

The one outlier at this point, which is the Seabrook -- the one plant here, I mean, here Seabrook has a 10^{-3} -- well, greater than 10^{-4} CDF based on the Livermore curves, but a 10^{-5} CDF based on the EPRI curves.

CHAIRMAN APOSTOLAKIS: So these are based on mean curves, right?

MR. LEHNER: These are based on mean hazards.

CHAIRMAN APOSTOLAKIS: All of them are on the mean curves.

MR. LEHNER: Yes. Yes.

CHAIRMAN APOSTOLAKIS: So, then, if we use uncertainty we might see a greater dispersion.

MR. LEHNER: Certainly, yes.

MEMBER POWERS: What do you mean a greater dispersion?

MR. LEHNER: I mean, I don't --

MEMBER POWERS: There's no difference.

CHAIRMAN APOSTOLAKIS: What?

MEMBER POWERS: What you would find is there's no difference if you put the uncertainties --

CHAIRMAN APOSTOLAKIS: I don't think so. No difference?

MEMBER POWERS: Yes, you would -- because there's uncertainty in the seismic CDF on both the horizontal and the vertical axes, the dots would be huge and --

CHAIRMAN APOSTOLAKIS: 95th percentile for Livermore is higher than for EPRI. So I should see some difference.

MEMBER POWERS: It would be indistinguishable relative to --

CHAIRMAN APOSTOLAKIS: It depends on what I choose to plot. It depends on what I choose to plot.

MR. LEHNER: Yes. I was going to say it

would depend on what you choose to plot.

CHAIRMAN APOSTOLAKIS: Of course it would.

MEMBER SHACK: But is this arising because as you go to the lower frequency level the EPRI curve is going a little bit -- I mean, you know, you get a factor of three at the low --

MEMBER POWERS: I think it's totally a statistical sampling.

MR. LEHNER: I mean, there's a comment --

MEMBER POWERS: If you calculated the uncertainty in that slope, recognizing the uncertainty in the values of the points, I guarantee you you would find no way to distinguish that from a 45-degree line.

CHAIRMAN APOSTOLAKIS: So it will be a scatter plot.

MEMBER SHACK: So there's a shift in the mean curve if you --

MEMBER POWERS: You might --

MEMBER SHACK: -- use a lower frequency. That's where --

MEMBER POWERS: Well, I think that's what they derive out of it, but I don't think it's a meaningful shift.

MR. LEHNER: There's been some speculation that the -- even though the curves are different that

the slopes of the hazard curves in those areas that -- that control the -- you know, the seismic response are not that different. That's one assumption.

MEMBER POWERS: The other thing I will hasten to point out is the regression line is also incorrectly calculated, because it assumes that the horizontal axis is totally certain.

MR. LEHNER: It's only there as sort of a guide to --

(Laughter.)

CHAIRMAN APOSTOLAKIS: Now, why did, then, two of the dots there are below the 45-degree line?

MR. LEHNER: Oh. That just means that it turned out that their EPRI CDF was bigger than their Livermore CDF.

CHAIRMAN APOSTOLAKIS: Yes. The question is: why?

MR. LEHNER: Oh. Why?

MEMBER POWERS: It can happen in any western state in the calculation.

CHAIRMAN APOSTOLAKIS: The widespread belief is that if you use the EPRI curves you get lower numbers.

MEMBER POWERS: It's eastern seismicity.

CHAIRMAN APOSTOLAKIS: And for the west

it's the reverse?

MEMBER POWERS: It's not the reverse. They are almost identical.

CHAIRMAN APOSTOLAKIS: So why are both the dots below the line, then? One should be above.

MEMBER POWERS: George, they're below the line by the width of a dot.

CHAIRMAN APOSTOLAKIS: So what does that tell us, then? That for the eastern United States Livermore is more conservative, right?

MR. LEHNER: Well, I think the -- the conclusion that we'd like to draw is that it doesn't make much difference which hazard curve you use.

CHAIRMAN APOSTOLAKIS: It doesn't make much difference.

MR. LEHNER: As far as your CDF is concerned. And it turned out that it didn't make much difference as far as the dominant contributors either. In other words, the ranking of the dominant contributors didn't change --

CHAIRMAN APOSTOLAKIS: But wait a minute. Why doesn't it make much difference? Look at the points on the left there.

MEMBER SHACK: Yes. But if you're at 10^{-6}, do you really care whether you're up or down a

little bit?

MR. LEHNER: Yes. I mean, let me -- maybe another way to illustrate this --

MEMBER SHACK: Where the action is they come together on the 45-degree line.

MR. LEHNER: There's a different way of looking at it. There's a figure out of the text. I mean, this basically compares, you know, Livermore's CDF versus EPRI's CDF.

CHAIRMAN APOSTOLAKIS: So this is the revised Livermore now, right?

MR. LEHNER: Revised Livermore, yes. Yes, revised Livermore.

MEMBER KRESS: And 14 and 15 are the two that are below the --

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: And you're sure these are western plants? 14 and 15?

MR. LEHNER: No. These are -- no, because we want some plants who use site-specific spectra.

CHAIRMAN APOSTOLAKIS: Okay. So it happened, then, for the eastern United States, which is an eastern -- maybe you have very strong values for --

MR. LEHNER: Well, I guess it depends on

where their seismic response is. If you'd like I can look up what plants those are.

MEMBER KRESS: I was wondering whether it had anything to do with the uniform spectrum that -- which gets kind of -- it gets convoluted with this.

MR. LEHNER: Well, yes. Pilgrim and Oyster Creek.

CHAIRMAN APOSTOLAKIS: Oh, okay. So they are both eastern United States.

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: Maybe the reason was that there were -- the analysts. Using EPRI and Livermore doesn't mean that you are using a concrete methodology. I mean, the analyst must play some --

MR. LEHNER: Oh, certainly.

MEMBER KRESS: You have to have success criteria, and you have to have the fragility of these things, and look at the response to different spectra. And I don't know. You know --

MR. LEHNER: Yes. But, I mean, again --

MEMBER KRESS: -- a lot of reasons you could end up --

CHAIRMAN APOSTOLAKIS: What's number nine?

MR. LEHNER: Number nine?

MEMBER SHACK: Seabrook.

MR. LEHNER: That's Seabrook. Yes, that's Seabrook.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER KRESS: You know, that almost has to be in response --

MR. LEHNER: Presumably, the analyst was the same for both the EPRI and the Livermore analyses.

MR. RUBIN: John, the high one was Haddam Neck.

CHAIRMAN APOSTOLAKIS: Nine was Haddam Neck?

MR. LEHNER: No, nine was --

MEMBER SHACK: No, Seabrook.

MR. LEHNER: -- Seabrook.

MR. RUBIN: I think 15 is Haddam Neck. Yes, that's Haddam Neck. It's the one with the EPRI curve. The EPRI is higher than the Lawrence Livermore.

MR. LEHNER: Yes, that's right. The highest one is Haddam Neck, but there is two --

MEMBER SHACK: The second one I think is Pilgrim.

MR. LEHNER: Yes, 11 and 14 -- 11 and 14 have the EPRI higher than the Livermore. Those are Pilgrim and Oyster Creek.

CHAIRMAN APOSTOLAKIS: Bob, you have a question?

MEMBER UHRIG: Well, just point out that this is a logarithmic curve. And take number one there, the difference looks very large, but it's insignificant compared to something like, say, 13.

CHAIRMAN APOSTOLAKIS: The blue and the red?

MEMBER UHRIG: Yes. You have to take that logarithmic scale into account when you're looking at those.

CHAIRMAN APOSTOLAKIS: But also now, since you mentioned one, I look at one and I look at 14, 15, or maybe nine, or the others, and there is a difference in CDF that is two and a half to three orders of magnitude. What are the two driving forces behind this? Why such a wide variability? Is it the design of the plants?

MEMBER POWERS: Where is this two and a half orders of magnitude difference?

CHAIRMAN APOSTOLAKIS: Well, it's 10^{-7} in one, two or three 10^{-7}, and then the other one -- 15 is two or three --

MEMBER POWERS: Oh, you mean across the spectrum.

CHAIRMAN APOSTOLAKIS: Yes. Yes. So what is the driver? Is it the design, or is it the analysis?

MR. LEHNER: Well, again, I think --

CHAIRMAN APOSTOLAKIS: Or where they are?

MR. LEHNER: I think it's a combination of those things. I mean, certainly the design and the location are going to play some role. I think these are site-specific hazard curves. But the analysis as well is going to -- you know, as we said before, the variation in the analysis obviously I think plays a role here, too.

VICE CHAIRMAN BONACA: Some of the older plants like Haddam Neck had -- inside an auxiliary building separated by walls, so there was very little hiding certain components from system interactions. And if you do an analysis, very vulnerable to that, there isn't much you can do. And some of the very low ones, of course, they were built and designed with poor separation and different concrete walls and structures that -- big difference comes from that, in part.

MEMBER KRESS: When they use a seismic hazards curve, do they have to estimate a distance away from the fault line, to adjust the curve for

that?

MR. LEHNER: Well, I mean, they -- I think they make a variety of assumptions to generate this family of hazard curves, including, you know, distance, attenuation, and then put certain weightings and probabilities on that. And that's why if you want to -- if you want to take the uncertainty into account, you should really propagate that whole family of hazard curves. But in this case it was a mean curve developed from a family of curves.

Listed here are the dominant contributors that were identified from the seismic PRAs. The first column is the seismic failures, and the second column are the random failures, and the third are the operator action errors that were identified as dominant contributors.

So, as you can see, a majority of the most frequently observed dominant contributors under the seismic failures had to do with electrical systems. You can see also listed here is the surrogate element which showed up in a few PRAs as one of the dominant contributors. We're going to talk more about that a little later on.

Some buildings also -- I mean, some structures like block walls and turbine building,

auxiliary building, also showed up in the dominant contributor column under the seismic failures.

In the random failure and operator action area, the diesel generator random failure was, again, prominent for both BWRs and PWRs. And the operator action errors for PWRs aligning aux feed was an operator action error that was high on the list.

For the BWRs it was mainly things related to power recovery as far as operator errors go that were identified as dominant contributors.

CHAIRMAN APOSTOLAKIS: "Random failures" means they failed -- it was out of --

MR. LEHNER: Not due to seismic, not due to seismic event itself.

So summary conclusions from the PRAs -- as I noted earlier, the electrical system components were the most frequent contributors. In about half the occurrences those were listed as dominant contributors. Building and structural failures were significant, and then the rest was made up by frontline and support systems and tanks.

And in about six to eight percent of the major contributors listed, the surrogate element played a role. And the licensees modeled -- usually you screened out --

MEMBER SHACK: Well, that's a funny number. Just, you know, it's seven out of 27 PRAs, but then you look at the fraction of the whole submittals. Why don't you just look at the fraction of the PRAs in which it was the significant element?

MR. LEHNER: Yes. Yes. That's true.

MEMBER SHACK: It's a lot more than six percent.

MR. LEHNER: Yes. Well, wait a minute. No, I'm -- this is where -- no, I think it -- I think the six percent is only for the PRAs. I mean, seven out of the --

MEMBER SHACK: Twenty-seven PRAs had it as a significant element.

MR. LEHNER: Okay. I'm sorry. Yes, I guess that's right. Okay.

MEMBER SHACK: Well, at least that's what the report says.

MR. LEHNER: Yes, that's right. No, you're right. You're right, yes.

CHAIRMAN APOSTOLAKIS: So you did not validate the results of the report. You just --

MR. LEHNER: Actually, you're right. I was confusing it with something else.

Regarding a surrogate element -- and we

can talk about that more later, but I should mention here that most plants that use a surrogate element used a single surrogate element for all of the screened out components.

But there were some that were -- did a little bit more discriminating, where they used several surrogate elements, like one for the -- all of the components in the aux building, another one for all of the components in the safe shutdown facility. So that gave you a little bit better insight into where the contributors lie.

We've already talked about the fact that the EPRI and Livermore hazard curves did not significantly alter CDF or the dominant contributors. And in general, we make the statement in the report that the CDF values did not necessarily trend upward with plant age.

And, you know, we mentioned that I think with some caveats that one could perhaps interpret this as saying that the seismic programs that have been implemented have helped to bring down the CDF of older plants to a reasonable level.

MEMBER POWERS: One would say that if they were at an unreasonable level prior to the imposition of the programs.

MR. LEHNER: Yes.

MEMBER POWERS: Do you know that?

MR. LEHNER: We don't know that, no.

MEMBER POWERS: So the alternate conclusion is that the programs have been useless.

MR. LEHNER: Well, you could take a positive view.

(Laughter.)

MEMBER POWERS: You may want to look at that language in the report, because you do this several times --

MR. LEHNER: Yes.

MEMBER POWERS: -- when you're talking about the SEP plants versus the more modern plants, and you come to the conclusion that -- that activities have made things better. There is -- the alternate conclusion is still left open.

MR. LEHNER: Well, I mean, quite frankly, we were struggling how to characterize that. And I'm willing to listen to suggestions.

(Laughter.)

MEMBER POWERS: Okay.

MR. LEHNER: How to best state that.

All right. Turning to the margin analysis, this is a histogram of the different HCLPF

ranges that were found in the margin analysis. And by the way, the only reason there are three figures here is just to distinguish the ranges a little bit better. I mean, people only reported HCLPFs to one or two places.

MEMBER SHACK: What was the cutoff at .3? Why didn't you just let them report what they found?

MR. LEHNER: Well, the screening was done at that level. In other words, the review level earthquake was at .3 g, so they screen out anything above that. So it would have taken a lot more effort for them to not screen them.

But that's an important point in looking at this HCLPF data because, as you said, if they could -- if each plant would actually calculate a plant HCLPF as high as possible, then you would probably see a different trend than you do if you cut it off at the .3 level.

VICE CHAIRMAN BONACA: You will probably see a lower CDF -- lower CDF for more recent plants, maybe more --

MR. LEHNER: A higher HCLPF for more recent plants.

VICE CHAIRMAN BONACA: Yes.

MR. LEHNER: Yes.

MEMBER POWERS: Is there a database that I can go to that says, "Okay. Here is the calculated HCLPF, and here is the actual performance of the device under various seismic loads or system or structure"?

MR. LEHNER: Well, I mean, the tables in EPRI 60-41 were based on that kind of a --

MEMBER POWERS: Yes. Okay. You're right. You're right.

MR. LEHNER: I should also mention that the HCLPF values shown here presume that the improvements have been made. I didn't mention this when we talked about improvements. But some of the submittals were somewhat ambiguous as to when those improvements would be in place. So the HCLPF values reported here are --

CHAIRMAN APOSTOLAKIS: Let me understand again what this means.

MR. LEHNER: Okay.

CHAIRMAN APOSTOLAKIS: If I take the second column from the right, .25, .299 --

MR. LEHNER: Right.

CHAIRMAN APOSTOLAKIS: -- I guess it's your left -- I see that 10 plants do what? That I have high confidence? What? What's my confidence,

99 percent?

MR. LEHNER: No, no. Well, the HCLPF is a 95 percent confidence at a five percent failure probability.

CHAIRMAN APOSTOLAKIS: So I am 95 percent confident that the probability of failure of those plants --

MR. LEHNER: It's no greater than --

CHAIRMAN APOSTOLAKIS: -- is five percent.

MR. LEHNER: It's no greater than five percent.

CHAIRMAN APOSTOLAKIS: It's no greater than five percent.

MEMBER KRESS: If the earthquake g is no bigger than that range.

CHAIRMAN APOSTOLAKIS: If the earthquake is no bigger, or if they are designed against such an acceleration?

MEMBER KRESS: Well, acceleration --

MR. LEHNER: It's that seismic demand that's being put on the plant. In other words, if I have a g level between -- these plants reported a HCLPF that says that an earthquake -- well, let's take the easiest case. The review level earthquake had a g level of .3.

So those plants that have a HCLPF of .3 or greater, they have a 95 percent confidence that their success paths will be available to shut the plant down safely at --

CHAIRMAN APOSTOLAKIS: Five percent of the time.

MR. LEHNER: No, 95 percent of the time.

(Laughter.)

MEMBER KRESS: It's bad to have a low HCLPF.

CHAIRMAN APOSTOLAKIS: So if my -- now, review level, you said -- but what does that have to do with the actual plant? The safe shutdown earthquake?

MR. LEHNER: Well, the review level earthquake is higher than the safe shutdown earthquake. That's the whole idea of the IPEEE. In other words, the safe shutdown earthquake is a design basis earthquake. That's what the plants were designed to.

So the review level earthquake was chosen to see how much margin these plants have above their design basis.

CHAIRMAN APOSTOLAKIS: It doesn't tell me that. If my SSE is .2, how does that affect these

figures? My SSE is .2.

MR. LEHNER: Well --

CHAIRMAN APOSTOLAKIS: And I do a HCLPF analysis with -- do I need the review level earthquake for a HCLPF analysis?

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: Okay. So I do it for .3.

MR. LEHNER: Yes.

CHAIRMAN APOSTOLAKIS: So what does that tell me?

MR. LEHNER: Well, it tells you what -- if your HCLPF is .3, then you have a high confidence that your plant will survive an earthquake that's, you know, 50 percent higher than your safe shutdown earthquake, if you have a safe shutdown.

CHAIRMAN APOSTOLAKIS: I don't know how much margin I have. I just --

MEMBER SHACK: It's your next plot.

MR. LEHNER: Yes. I was going to say, let's go to the next plot. I mean, this basically shows you -- this plots the ratio of the plant HCLPF to the SSE value versus the SSE g level.

And the dashed line is -- you know, is at one. In other words, those plants have a HCLPF that's

just equal to their safe shutdown earthquake. And both of those plants are -- I mean, in some cases, these are plants that did reduced scope analyses. And in some cases they did not report a HCLPF, so by default we just gave them a HCLPF that was equal to their safe shutdown earthquake.

The solid line is the highest HCLPF that the plant could report because of what we talked about a little while ago about the fact that the screening level was at .3 g. So a plant can't report a HCLPF above .3 g, because they've screened out the components at the 3 g level, so they never evaluated those components.

So you have to assume a .3 g limit. But this shows you the margins, basically, that the plants have above the safe shutdown earthquake based on this HCLPF calculation.

CHAIRMAN APOSTOLAKIS: So give us an example. Pick one.

MR. LEHNER: Well, I mean, if we -- if we pick this plant here, it basically says that its HCLPF value is twice the value of the safe shutdown of -- the design basis of the safe shutdown earthquake.

CHAIRMAN APOSTOLAKIS: That still doesn't tell me what the probability of failure is, though.

It just tells me that the HCLPF value is --

MR. LEHNER: It doesn't -- well, I mean, it says you have a high --

CHAIRMAN APOSTOLAKIS: In terms of g, in other words.

MR. LEHNER: Yes. I mean, you have the high confidence --

CHAIRMAN APOSTOLAKIS: I do, because I already have high confidence for the review level. So if you were down --

MR. LEHNER: Well, but this shows you that, yes, you have --

CHAIRMAN APOSTOLAKIS: I don't multiply -- I don't divide the probability by two. Okay? I mean, I just -- I can only say that I have high confidence.

MR. LEHNER: Yes. I mean, you can't get a quantitative -- yes.

CHAIRMAN APOSTOLAKIS: How much I have I don't know.

MR. LEHNER: Right. That's right. I mean, it does not tell you a -- it doesn't give you a probability.

CHAIRMAN APOSTOLAKIS: Right.

MR. LEHNER: The other issue on this plot is that we distinguish between plants who, in their

analysis, use a new structural analysis or plants that simply scaled up their analysis from their SSE, because when plants use a new structural analysis they -- by eliminating many of the conservatisms that they used when they did the original design basis calculations, the actually reduced their seismic demand.

And, therefore, the HCLPFs that they calculated would have been -- were different or higher than if they had used a more conservative method. So one has to distinguish between how to calculate it -- that HCLPF, and that's why you've got the triangles -- the solid triangles and the open squares.

Now, this is a list of the weak links that were the outliers that were found in the SMA. So this is not necessarily -- I mean, one can assume, as one does with a PRA, that these are the dominant contributors.

But, nevertheless, these are the -- in the success path, when they calculated the capacities of their SSCs and the success paths, these were the -- those SSCs and the success paths that had the lowest capacity -- in other words, were the weak links in the analyses.

CHAIRMAN APOSTOLAKIS: And the licensees

did something about it?

MR. LEHNER: Well, I mean, they -- in some cases they did, and in some cases they didn't. I mean, the -- getting a plant HCLPF that was lower than the review level earthquake was not a problem as far as the IPEEE guidance was. In other words, it was an assessment of the plant's capacity. It does not mean that every plant had to have a plant HCLPF above the -- equal to or above the review level earthquake.

Certainly, if the HCLPF was below the design basis, then the plants would fix things so that their HCLPF at least came up to the design basis. But there were plants that have HCLPF values that were below the review level earthquake value.

CHAIRMAN APOSTOLAKIS: So that did something about it. I mean, the numbers that you have shown us so far reflect those changes.

MR. LEHNER: Yes. Yes. These numbers reflect those changes, and, as a matter of fact, as I said, the -- in some cases, the analysis was done by the plants before they had actually implemented those changes. So, you know, one of the follow-ups here would be to make sure that those changes were actually implemented.

MEMBER LEITCH: This does not list

directly loss of offsite power.

MR. LEHNER: Well, in the margin analysis, loss of offsite power was assumed as being unrecoverable. So they -- that was part of the guideline of the margin analysis. They basically -- in a seismic margin analysis, you assume that you lost offsite power and you are not going to recover it.

CHAIRMAN APOSTOLAKIS: I wonder about -- are they concerned at all about the human performance to the margins calculations?

MR. LEHNER: Yes. They -- the success paths that the licensees chose -- the guidance was that they should choose success paths that did not require, you know, extraordinary human performance, and that the -- the actions that would be required would be reasonable to carry out under seismic conditions.

And as I mentioned before, the margin analysis talked about this to some degree. In many cases, they elaborated on it when we -- we asked them RAIs in this area, because this was an area that often was not discussed thoroughly in the submittals.

But in responses to RAIs, they talked about the timing and location of these actions, and provided some justification why these actions were

feasible under the conditions that they were taking place. But that was the way they addressed the actions.

I mean, generally, you can see that the weak links that are listed here are similar to the dominant contributors that were identified in the seismic PRAs.

Now, I should also mention here -- we talked earlier about a statement in the report that talked about the success path, the way they were developed in the margin analysis, and that some licensees did not completely follow the guidance provided in EPRI 60-41. And that refers mainly to the fact that the success paths were supposed to be as independent as possible, and some licensees described success paths that used the same equipment for some of the functions.

Basically, the success paths had to identify ways of controlling reactor reactivity, reactor pressure, reactor inventory, and decay heat removal. And in some cases plants identified, as redundant success paths, let's say, two different trains of the same system.

So the diversity that you wanted was not necessarily there. And the reasons for this in some

plants was simply because they didn't have seismically qualified equipment to give you the diverse paths. In other cases, it seemed to be a -- well, there was perhaps a reluctance to go and do further analysis to establish a completely different success path, if you've had some seismically qualified equipment that could accomplish the safe shutdown.

MEMBER LEITCH: In considering the time for operator actions, do you know if they considered time for diagnosis? It's not always apparent that you've had a seismic event. I was telling some of the guys at the break that I was in charge of a plant that was in a fairly industrial area -- a fossil plant -- and we had an earthquake. And it must have -- I was at home asleep at the time, and it woke me up and I called the plant.

It must have taken us half an hour before we figured out that we had an earthquake. I mean, we were, first of all, looking around for what might have exploded in the plant -- you know, things like aux boilers, generators, thinking a hydrogen explosion. Then we thought about, you know, some of the adjacent refineries, did they have some kind of a problem or --

MR. LEHNER: Yes.

MEMBER LEITCH: You know, it took a little

while to say, "I don't know what else it was. It must have been an earthquake." You know, but it took a while to reach that conclusion.

MR. LEHNER: Well, I mean, the -- you know, the need here is not necessarily to realize you've got an earthquake, but to -- to respond to whatever the problem in the plant is as far as getting your safety systems in place.

But to answer your question, I think the people that did PRAs usually adopted the human error methodology that they used in the internal events. And then, depending on the methodology they used, you know, there was a diagnostic component. And then, for their external events, they -- as we discussed earlier, simply put multipliers on some of those failure rates.

The margin analyses talked about time available to do the action. They did not necessarily talk about the different phases of the action, but they certainly talked about the fact that they would not credit actions that had to be done very quickly under -- where you had to realize very quickly what was wrong and take actions very quickly. So they did, in general, use actions that you would have a lot of time to implement.

MEMBER POWERS: I'm wondering with symptoms-based procedures why the multiplier is different from one.

CHAIRMAN APOSTOLAKIS: In what? Systems-based procedures?

MEMBER POWERS: Symptom-based.

CHAIRMAN APOSTOLAKIS: Oh, symptom. Symptom.

MEMBER POWERS: In symptom-based procedures, why is the multiplier different than one?

MR. LEHNER: The control room ceiling is falling down here.

MEMBER POWERS: Those are one-time events and it's over with. I went through the San Fernando Valley earthquake, and we had to respond to chemical problems. And I don't think our response was any different than if we would have done anything else.

MEMBER KRESS: Could it be, Dana, that when you have an earthquake that you actually invoke multiple sequences at the same time?

MEMBER POWERS: Well, if that's the case --

MEMBER KRESS: And the symptoms are confusing, then.

MEMBER POWERS: Well, I mean, if you have

a multiple -- if you have multiple events going on in a control room at a time, when you do the human reliability analysis you take that sort of thing into account -- or should. And maybe -- or maybe it's just more ordinary -- that's more ordinary in an earthquake event. I don't know.

MEMBER KRESS: Yes, that would have been my guess.

MEMBER POWERS: The fraction level was high.

CHAIRMAN APOSTOLAKIS: The story Graham tells is that they may not even realize it's an earthquake.

MEMBER KRESS: Well, I sort of liked your thing, too. You don't care. You just look at what is going on in the plant, and that's what the symptoms-based do. But I suspect if the earthquake is big enough to give you substantial contribution to the CDF, you probably have a lot of things going on, and that's where the operator confusion might go in, and induced LOCA and induced loss of offsite power at the same time, that sort of thing -- going on simultaneously it seems to me like.

MR. LEHNER: I think the multiplier perhaps is a crude way of compensating for that sort

of --

MEMBER KRESS: Yes.

CHAIRMAN APOSTOLAKIS: It multiplies a number that's --

MEMBER KRESS: It's crude. If you multiply a crude number by a crude number, you get a really crude number.

MEMBER POWERS: Well, I'm still perplexed how they picked the multiplier.

CHAIRMAN APOSTOLAKIS: It's an engineering judgment.

MEMBER KRESS: Yes, that's perplexing.

MEMBER POWERS: I don't even know how they have any judgment in this matter. Probably it's one of those things that I can undoubtedly derive from the superior work being done at the Haldrin program.

MEMBER KRESS: I'll tell you how it's derived. You know it's bigger than one. Ten is too big. So what do you do? You choose five.

CHAIRMAN APOSTOLAKIS: Actually, in Japan I believe they did experiments where they put the --

MEMBER POWERS: I mean, that's not --

CHAIRMAN APOSTOLAKIS: But I don't know what that means. I mean, this is almost like what is indicated -- proposed about the gas reactor.

MEMBER POWERS: I mean, if you're going to -- you have to remind yourself that an earthquake occurs, and it's usually a substantial amount of time -- hours -- before the next aftershock comes. Okay? During that period, my experience with the earthquake, actually things are kind of quiet and calm, because, you know, traffic and what-not.

MEMBER KRESS: Best time of the day, isn't it?

MEMBER POWERS: All the fans --

(Laughter.)

-- and things like that. All you hear is the blowing of the wind through the broken-out windows.

MR. LEHNER: So turning to some insights on the margin analyses, again, the electrical system components were often the governing outliers. Building and structural failures, especially block walls, were significant as far as weak links go. And then balance of the weak links went along the frontline support systems.

As that figure previously showed, the seismic margins in terms of the HCLPF being above the design basis earthquake do vary significantly among the plants. And similar to the PRAs there was no

observable correlation between the HCLPF values that were calculated for the plant and the plant age.

But, again, as we talked earlier, that statement has to be qualified with the fact that you couldn't calculate HCLPFs higher than .3 g based on the screening methodologies used.

And, finally, it's important to note that with the improvements taken into account there were no plants that had HCLPF values below their safe shutdown earthquake value.

MEMBER KRESS: Okay. Is that true for the plant on your slide four slides back that had a HCLPF value in the range of .1 to .15?

MR. LEHNER: Yes. Matter of fact --

MEMBER KRESS: That was this safe shutdown?

MR. LEHNER: That plant -- as a matter of fact, I believe that's Quad Cities. That plant originally had a HCLPF of .09, but they committed to making some improvements that got it into their view range.

MEMBER UHRIG: One question on the electrical system components here. Was this mostly failure of the components? Was this the wires being disconnected?

MR. LEHNER: Well, some of it was relay chatter.

MEMBER UHRIG: Relay chatter.

MR. LEHNER: Yes. But some of it was, you know, diesel generator.

MEMBER POWERS: I thought you told us that was all fixed.

MR. LEHNER: Well, but some of the weak links were still those relays.

MEMBER POWERS: This will all be solved when we go to digital systems, by the way.

(Laughter.)

MR. LEHNER: All right. The methodological issues -- I think we talked about most of these, actually all of these I guess. We've talked about the fact -- you know, from hazardous spectrum, some of the comments in the reports state that there -- it's uncharacteristic as compared to conventional spectrum shapes, and use led to a reduction in seismic demand.

Use of surrogate elements -- in general, this would not be a problem if it was used properly; that is, if the screening level was set high enough so that the element would not show up as a dominant contributor.

And by the way I should mention here that there were some plants that simply threw away their screened out components. I mean, they did not even include them in a surrogate element. So at least the ones that used surrogate elements have knowledge that there could be a contribution from those components.

We talked about the new SSI calculations versus scaling, and how the HCLPFs that were obtained should not be compared directly but should be compared with each other but not -- not necessarily across. And we also talked about the fact that the component fragility calculations varied in quality due to the -- some of the estimates on the uncertainty and other things that went into those calculations.

MEMBER KRESS: Would you elaborate a little more on your second bullet? Why is that a problem? It's a dominant risk contributor. Because it may be overestimating the risk?

MR. LEHNER: No, because you don't -- I mean, the surrogate element lumps all of the things you screen out together.

MEMBER KRESS: Yes.

MR. LEHNER: So if the surrogate element shows up as a contributor, you don't know --

MEMBER KRESS: You don't know whether it

was or not.

MR. LEHNER: -- well, which of those things that you screened out.

CHAIRMAN APOSTOLAKIS: But it warns you to go back and look, right?

MR. LEHNER: Well, that's true, yes.

CHAIRMAN APOSTOLAKIS: I mean, that's the purpose of it.

MR. LEHNER: Absolutely. But what that would mean is you would have to look at -- you would have to set your -- yes, it was not --

VICE CHAIRMAN BONACA: So you have a surrogate element that is dominant, and you're saying, wait a minute, what's here? And then you -- so what do you do? You seismically qualify it. I mean, it leaves you hanging there.

MR. LEHNER: I mean, I suppose what you do is raise your screening level and --

CHAIRMAN APOSTOLAKIS: Absolutely.

MR. LEHNER: -- screen in more components and --

MEMBER SHACK: Right. Well, again, if your risk is 10^{-6} --

MR. LEHNER: Right.

MEMBER SHACK: -- you know, there's the

dominant element.

MR. LEHNER: Yes, you're absolutely right. Exactly.

MEMBER POWERS: Unless it's a metallurgical issue, in which case you can --

MEMBER KRESS: But if you have a large number of components that might fail simultaneously due to something like the seismic, or might have a decreased reliability all because of some common reason, would that be a good way to determine an importance measure like Fussell-Vesely or Rowell, if you just used surrogate elements instead of trying to do it for each individual one? Is that a legitimate way to get an importance measure for those things?

MR. LEHNER: No.

MEMBER KRESS: This is another issue is the reason I'm bringing it up.

MR. LEHNER: No, I don't think so. I mean, I'm not sure I follow you completely, but I --

MEMBER KRESS: I mean, it seems to me like it gets the -- it adds up the importance of all of the things you lumped into that surrogate and --

MEMBER POWERS: Does it add them up, or does it take the geometric mean?

MEMBER KRESS: Well, that's what I'm

trying to get at. I think it maybe takes the mean, so it doesn't really add them up.

MEMBER POWERS: I mean, it's equivalent to adding it up -- one of them is very important, and the others are kind of in the -- I mean, that's the equivalent.

MEMBER KRESS: I think you're probably right.

CHAIRMAN APOSTOLAKIS: I think it's an overestimate.

MEMBER KRESS: Yes.

CHAIRMAN APOSTOLAKIS: It's an overestimate. So human error should be --

MR. LEHNER: Yes, should be one of those things mentioned.

MEMBER POWERS: Let me ask a question. In the final analyses of these we saw quite a range of assessments on the probability of bypass events being created by seismic events. Within the PWR subset of those things, when they analyze things like steam generator tube behavior under accidents, did they analyze the as-constructed tube behavior, or did they look at the degraded tube behavior?

MR. LEHNER: I don't believe that they looked at degraded tube behavior. As a matter of

fact, let me ask Jimmy if he recollects. Did anybody mention --

MR. XU: No. No.

MR. LEHNER: I don't think anybody looked at degraded.

MEMBER POWERS: So this pain that shows up in this document to the -- how useful the walkdown was to find the as-built/as-operated plant may apply in a lot of areas, but it certainly doesn't apply to steam generator tubes.

MR. LEHNER: I would agree.

MEMBER KRESS: It's kind of interesting because you would expect they know pretty much how degraded their steam generator is.

MEMBER POWERS: Yes. I mean, one of the advantages of the current condition monitoring program is you have a pretty good idea what your degradation is. What they don't have I think is they don't have a clue how shaking around of the support plates and what not would affect things. I mean, all they know is piston behavior.

That would be a difficult calculation to do, but it probably casts real doubt on the bypass fractions, which are spread. But I don't believe any of them.

And bypass, by the way, is not a trivial consideration here. Bypass accidents are consequence-producing things.

MR. LEHNER: All right. Coming up to the last slide, here are the conclusions that are stated in the report. Well, no vulnerabilities were identified by most plants. There were significant improvements made based on outliers and anomalies that the analyses identified. The analyses basically took account of these improvements. Seventy percent of the plants proposed improvements of one sort or another, and based on their seismic analysis.

The walkdowns, as we talked about, were probably a very important part of the IPEEE, with the most important part for those plants that only did reduced scope evaluations, and many of the improvements were carried out based on those walkdowns.

The margin analyses and the PRAs seem to point to similar components as dominant contributors in the PRAs as well as weak links in the margin analysis. Based on these analyses, the age of the plant was not, in general, found to be a major factor as far as the seismic risk. And the submittals indicated -- the submittals in the RAI responses, I

should say, indicated that the IPE program was successful in meeting the general intent of Generic Letter 88-20, Supplement 4.

And the licensees did carry out a lot of modifications that reduced their seismic risk, but it should also be stated that the -- the way it's stated here -- the success of the licensees varied, depending on the methods and assumptions used. I think it's fair to say that while everyone met the intent of the Generic Letter, some licensees made a larger effort than others and probably got greater benefits than others from this.

MEMBER UHRIG: I find that one statement a little puzzling. The seismic risk in the older plants was comparable to the newer. And yet, when you look at the seismic strengths, they went from very simple things with an order of $100 per unit to the next generation it was $1,000 per unit, and the following generation it was $10,000. Very sophisticated seismic constraints. This implies that was a waste of money.

MR. LEHNER: Yes. I think one -- I mean, one point, again, to make is that probably if you evaluated the HCLPFs, the plant HCLPF without having this .3 g cutoff, we would find that the newer plants

would have substantially higher HCLPFs than some of the older plants. That's my guess.

Any other questions?

CHAIRMAN APOSTOLAKIS: Any other comments from the members? No?

Thank you very much, John.

MR. LEHNER: Thank you.

CHAIRMAN APOSTOLAKIS: I suppose we can start with the fires now. We have to go until 12:30.

MEMBER POWERS: I will acknowledge to members that I sometimes hang out with the speaker. At least I know what he is.

But I will also point out that during the course of him doing this study he absolutely would not let me even see a hint of the thing. He jealously guarded it as though it were actually a precious commodity. I shall not forgive him for his secretiveness.

CHAIRMAN APOSTOLAKIS: If you cannot forgive, you cannot review.

(Laughter.)

MEMBER POWERS: What?

CHAIRMAN APOSTOLAKIS: If you cannot forgive, you cannot review.

MR. NOWLEN: You'll have to recuse

yourself for having a grudge against me.

(Laughter.)

MEMBER POWERS: No. I just intend to get even.

MR. NOWLEN: If you would prefer, we can defer this. But --

MEMBER POWERS: Were you talking about deferring it until next week or --

MR. NOWLEN: Until after lunch.

MEMBER POWERS: Oh. George, you know, if you want to get started, we'll get started. If you want to defer this until after lunch, we can. But that's entirely your choice here.

CHAIRMAN APOSTOLAKIS: Why don't we start and go for about half an hour.

MR. NOWLEN: Okay.

CHAIRMAN APOSTOLAKIS: You've got some introductory stuff to show us?

MR. NOWLEN: Sure.

CHAIRMAN APOSTOLAKIS: Okay.

MR. NOWLEN: Of course. Okay. Well, my name is Steve Nowlen. I'm with Sandia National Laboratories. My role in the IPEEE process was primarily as a member of the Senior Review Board. So at that level, I participated in virtually all of the

reviews.

There were a couple of the very early ones that I wasn't involved with, but after the first couple I did get involved, so I was involved at some level in virtually all of these. And I also led the Sandia team that developed the insights report that we're talking about today. It was a team effort, and I'll acknowledge my team members as key contributors as well.

The outline that I'm going to follow is quite similar to the other portions of the presentation. I'll give you some introductory material. I'm talk about the vulnerabilities that came out of the IPEEE process. I'll talk about plant improvements, CDF perspectives.

We'll do some discussion of where the dominant contributors came from based on the IPEEEs. Some discussion of methods and modeling perspectives. There is a lot of material in the report on methods and modeling. We can't go into all of it, so we'll cover some of that, and then I'll cover some conclusions.

Okay. In the way of an introduction, one thing to recognize is that all of the IPEEE submittals did include an assessment of the internal plant fire

scenarios.

And all of the licensees chose some form of a probabilistic method to assess fire, but also recognize that their submittals vary almost as much as the plants themselves vary. I mean, there was a wide range of choices made in both general and specific methodologies, so it -- comparing one to another can be problematic in that regard.

In general, you can categorize the methods used in three ways. There were those licensees who relied almost entirely on FIVE. And FIVE is -- essentially stops at the level of a quantitative screening analysis. So you get qualitative and quantitative screening. And if you stop FIVE that's basically where you stop.

Most licensees chose to go beyond that. Almost all of the licensees used FIVE to some extent, but most of them chose to go on, and they typically quantified the contributions from the unscreened scenarios. So they would not stop simply at screening; they would continue on.

And so you got into various forms of PRA, and some of these were new PRA studies, some of them were updates of old PRA studies, and then there were a couple of plants that actually used a fire event

tree approach, which was an update of very early risk studies that were done. And so they were a little bit unique. But, again, it was a probabilistic method, albeit a very early probabilistic method.

MEMBER POWERS: Where within this spectrum lies what is referred to in the report as F PRA IG?

MR. NOWLEN: The fire PRA implementation guide would be two types. There were some utilities who began with the FIVE methodology and then did their PRA quantifications using the fire PRA implementation guide. There were also a small number of licensees who jumped straight into PRA based on the fire PRA implementation guide.

So they would fall under the second group, the various forms of PRA. That's one of those various forms, or actually two of those various forms.

CHAIRMAN APOSTOLAKIS: When you say updates of early analyses, what are these earlier analyses?

MR. NOWLEN: Well, a lot of plants already had preexisting PRAs. For example, the NUREG-1150 plants had preexisting PRAs that were out there. And so rather than starting from scratch, they began with that and updated it and submitted that as their IPEEE.

CHAIRMAN APOSTOLAKIS: So these were fire

PRAs, then.

MR. NOWLEN: Yes. Yes, in most cases.

CHAIRMAN APOSTOLAKIS: Because you make a distinction there. You say fire event tree approach.

MR. NOWLEN: Yes, the fire -- well, the fire event tree approach goes back to a very early report published by an unnamed laboratory -- Sandia, of course -- 1978. It was a methodology that was published before the work at UCLA really hit the streets -- very, very early event tree type approach, more subjective.

CHAIRMAN APOSTOLAKIS: So some licensees use that?

MR. NOWLEN: Yes. Two plants.

MEMBER POWERS: Those with good taste.

(Laughter.)

MR. NOWLEN: Well, I'll not comment yet.

There were two plants in particular that had done preexisting risk studies using that method, and so for their IPEEEs they chose to update those preexisting analyses rather than start from scratch with a new analysis. And so they followed the same approach, updated the results, and submitted that as their IPEEE. But it's not the quantitative PRA that you're familiar with.

CHAIRMAN APOSTOLAKIS: Okay.

MR. NOWLEN: It's a different one.

When it comes to vulnerabilities, the situation is, again, similar to seismic. There wasn't a specific definition of what constitutes a vulnerability provided by the NRC, so the licensees came up with their own definitions. In some cases there was no explicit definition provided.

For those who did provide explicit definitions there was a range of criteria applied. These are more or less in the commonality, listed in the frequency with which people used a particular definition. The NEI severe accident closure guidelines, for example, were the most commonly applied.

And then there are a variety of other criteria that people used in order to define what constituted a vulnerability. Some -- the most recent was singles. As long as I didn't have any areas that led directly to core damage, I didn't have a vulnerability, and that was -- a couple of plants use that kind of a definition.

So when you look at what we got out of the studies in terms of identifying vulnerabilities, we did, in fact, have two cases. And both of these were

mentioned earlier this morning. The first one was Quad Cities, and based on their initial analysis -- and, again, these are plants who at some point in the process defined the vulnerability and said, "Yes, we have a vulnerability," and I'll clarify that.

In their initial analysis, Quad Cities did conclude that there were potential fire vulnerabilities. It was associated with turbine hall fires, and, in particular, large oil fires in the turbine hall that led to loss of safe shutdown equipment and, in particular, cables that were routed through the turbine building to the reactor buildings.

There was a proximity issue associated with their remote shutdown panels that were also located in the turbine building. As a result of those proximities to the fire, they took relatively low reliability for their operator recovery actions to take remote shutdown actions. And there was also a fairly significant contribution from the reliance on the sister unit equipment for shutdown, and the outage time associated with the sister unit also turned out to be a fairly significant factor.

What Quad Cities did is under considerable attention from the NRC, both from Research and NRR, there was a requantification analysis performed. And

the ultimate conclusion of that reanalysis was that there were, in fact, no vulnerabilities remaining at the plant.

The reanalysis relaxed some of the conservatism that was in the original analysis. For example, there was some additional cable tracing. They had assumed certain cables would be lost. They went back, traced, found out that they were in different areas and took credit for that.

There was also some relaxation of system impacts. They had assumed if any cable associated with a particular system were lost that system would be lost. They relaxed that to say, well, certain cables aren't as important as others. We may not lose the system function. We may lose an indication or something else, but the system function would be there. They took some credit for that.

And they also refined various aspects. They dug a bit deeper. They sharpened their pencil. They looked into aspects of the analysis that have been handled in very simplistic ways and refined that. And, in addition, there were some plant changes made in response to the initial analysis that were also credited in the reanalysis. So, again, based on the reanalysis, they concluded that the vulnerability

didn't exist.

MEMBER LEITCH: Steve, my question would be: is Quad Cities unique in this situation? It would seem to me that many plants would have this kind of vulnerability. And is it true that they do not? Or was Quad Cities just -- just came upon this and others perhaps overlooked this vulnerability?

Because I guess what I'm saying is if Quad Cities made some changes to improve it, what about the other plants that might have similar vulnerabilities?

MR. NOWLEN: Sure. There were some unique things about Quad Cities, clearly. There were aspects of the situation there -- in particular, the location of the remote shutdown panels in relative close proximity to these fires they were postulating -- relatively unique.

In the IPEEE process, we did focus considerable attention on turbine buildings. And so we asked a lot of licensees very specifically about their turbine buildings, and they typically responded with answers that satisfied us that there was not a similar situation there.

There are, of course, exceptions and one of them is our second vulnerability case, which was Millstone -- Millstone Unit 2. In the case of

Millstone the initial analysis concluded there were no vulnerabilities. There was an outlier identified.

They didn't call it a vulnerability -- they called it an outlier -- associated with storage of some transient combustibles in proximities to some important cables and they identified some resolution paths for that.

But in part because of knowledge of members of the Senior Review Board about this plant and things we had seen from Quad Cities, they were specifically asked about their turbine hall analysis. And in response they did come back and say, "Yes, you're right. We found a vulnerability in the turbine hall."

In this case, they focused on two particular scenarios that each came in with an as-found estimate of risk that was very conservative CDF of on the order of $4E^{-4}$, conservative analysis, conservative assumptions. The reason that they had, then, missed in the original analysis was that they had underestimated the CCDPs associated with these particular scenarios.

And in this case it was the original analysis that assumed these CCDPs would be two times 10^{-3}. And when they went back and looked again at

what equivalent was going to be lost, they concluded it was one times 10^{-1}. So .1 -- very substantial jump there.

And so as a result, they implemented some improvements. In particular, the turbine driven auxiliary feedwater vulnerability was fixed. This basically derived from a vulnerability of that particular system, and they implemented changes to remove that vulnerability.

They weren't real explicit about exactly what those changes were. But their requantification ultimately showed that the CDFs were on the order of $2E^{-7}$ and $2E^{-8}$ for these two scenarios in particular. So the fix really dropped the CDF quite considerably.

MEMBER LEITCH: But it seemed to me in the Millstone case, from what I read hear, that initially it was like 10^{-7} or 10^{-8}.

MR. NOWLEN: Yes.

MEMBER LEITCH: And then they --

MR. NOWLEN: They screened, initially, in fact.

MEMBER LEITCH: Yes. And then there was some attention brought to bear on this by the NRC and they --

MR. NOWLEN: Yes.

MEMBER LEITCH: -- looked at it and they said, "Ah, it's 10^{-4}." And then they did some fixes and brought it back up to 10^{-8} again.

MR. NOWLEN: Correct. Yes.

MEMBER LEITCH: And I guess -- were these -- was there special attention given to Millstone as a result of the rest of the scrutiny that Millstone was under at this time? I mean, I guess --

MR. NOWLEN: No.

MEMBER LEITCH: -- what I'm wondering is, would this have surfaced at another plant?

MR. NOWLEN: Yes, we believe so. Yes. We asked a lot of licensees about their turbine halls. Unless we got a really good analysis of the turbine hall that said, "We've looked at it in detail, and it's not important to us," or we got someone who did a good analysis and said, "Yes, it's an important area" -- and you'll see later that a lot of people did identify the turbine hall as an important fire area.

We asked a lot of licensees about that area and said, you know, "Look, we're not satisfied with the analysis you've done here. Please give us more." And we got a lot of good answers on that, and so a lot of people did go back.

And in this one particular case the

vulnerabilities surfaced, but that was the only other case where the vulnerabilities surfaced.

VICE CHAIRMAN BONACA: The reason why I asked the question at the beginning of the morning, the question that Graham is asking, because there are some sister plants which are pretty much identical in configuration, locations, etcetera. So the question would be -- normally, when you have a finding like this, you go back and ask the other guys exactly the same issue.

Now, you were pretty unspecific about what the fix was, except in the text it speaks of the turbine-driven aux feed pump.

MR. NOWLEN: Yes. That was the -- for Millstone that was the extent of the information we got.

VICE CHAIRMAN BONACA: So, you know, I'm left with the question -- did the other guys look the same way? Didn't find it because of that? Or is it something else?

MR. NOWLEN: Well, again, all I can say is we did specifically focus licensees' attentions on this issue. We directed them to consider what happened at Quad Cities, and later what happened at Millstone and Quad Cities. And we asked them to

consider similar issues for their plants. And the answers we got back were, "No, we don't have the same kind of issue."

So we took that at face value and stopped, unless we had reason to, you know, say, "Well, wait a minute. Your analysis missed this one point." In some cases, we went back a second time and asked again, but ultimately in all of the other cases we were satisfied they had addressed it and didn't have a similar vulnerability. Okay?

So jumping to plant improvements, we did see quite a wide range of plant improvements identified by licensees. And it's worth pointing out that the status of these improvements, as in the case of seismic, isn't always entirely clear. It includes things that were considered and rejected. We've actually counted those.

There's a few cases of that where people said, you know, we identified some things but decided they weren't cost effective or weren't of sufficient impact to pursue, things that were considered and implemented, things that were being considered, things that we're going to think about in the future, and things that were simply identified as a potential benefit without any real discussion of how that was

going to be addressed.

But overall a majority of the licensees did identify at least one plant improvement. And this was -- 44 of the submittals, 44 of the 70 submittals included at least one fire-related plant improvement, and that represented 62 units -- those 44 submittals. And that's 64 percent of the submittals, so I think that's a good thing.

And the plant improvements, again, similar to seismic, they fell into three common categories and that's operating procedures and training practices. That was almost half of the improvements that were associated with that.

Maintenance procedures and practices, a smaller number -- about 12 percent -- were associated with that. And then physical design changes were fairly highly represented as well, and these ranged from minor things to fairly substantial things.

So, again, there's a range in each of these, but a fair spread. And, in particular, the physical design changes -- quite a good representation of changes beyond simple procedures.

MEMBER LEITCH: We're under the impression that the February San Onofre event was made considerably worse by the fact that there were

barriers missing between certain breaker compartments, and the fire propagated from one to the other.

MR. NOWLEN: Yes. And really --

MEMBER LEITCH: Has that kind of thing surfaced as something which should be in a maintenance procedure?

MR. NOWLEN: I can't recall anything like that, and I'm not familiar with the San Onofre event, so I don't have a lot of detail there.

MEMBER LEITCH: Okay.

MR. NOWLEN: But I don't recall things along those lines, no.

MEMBER LEITCH: Okay.

MR. NOWLEN: Okay. Again, getting more specific, there were a range of issues identified in these improvements or addressed in these improvements -- emergency procedures, enhancements to identify -- or to address identified fire risk scenarios.

For example, they would take scenarios that were identified in the IPEEE and look at their procedures and adjust them to reduce the likelihood that things would go bad in these events. Operator training -- some of the licensees, for example, cited that they were using scenarios from the IPEEE process to develop new training scenarios for the operators,

specifically simulating some of the things they were postulating in the IPEEEs in terms of scenario development.

Fire brigade training, an additional detail -- or additional attention to the firefighting and dominant fire areas -- in particular, pre-planning, additional fire drills, that was fairly commonly cited.

General maintenance procedures tended to focus on things like housekeeping, transient combustibles, additional requirements for fire watches, reduction of fire hazards, that sort of thing.

In terms of the physical changes, we saw cases of relocating equipment and cables to remove them from the critical fire area or to reduce the fire hazard associated -- or the fire hazard presented to those pieces of equipment. Some fire protection system modifications and upgrades, fire barrier changes and upgrades that people were citing, and in a few cases we saw electrical design changes, system design changes -- in particular, plants who looked at spurious operation potential.

In a few cases we had plants that came back and said, "Well, we've made a design change to

the system to reduce the likelihood of spurious actuation in order to reduce particular scenarios."

MEMBER POWERS: The general category of spurious actuations, do you find any difference -- consistent difference between those plants that have self-induced station blackout and those that do not?

MR. NOWLEN: It's a tough question. We did have --

MEMBER POWERS: I wouldn't ask it if it wasn't hard.

MR. NOWLEN: Yes.

(Laughter.)

We didn't, and we did, in fact, question a number of licensees regarding the issue of self-induced station blackout. We did have access to the Brookhaven report on that subject, and during each review we would look at that report, and if it was a plant that fell into one of the categories we would specifically look at the submittal for that kind of information.

We typically didn't see it in the original submittals. It would not be discussed. We would then go back to the licensee and ask them a question about how they had addressed that.

This gets wrapped up a bit into the

general issue of main control room abandonment and how they did human factors for main control room abandonment. The typical response we got back was that they considered that even looking at SSPO issues, the number they've used for reliability of remote shutdown reflects the probability that those procedures would fail and that they consider it conservative.

Others provided us with some additional detail as to what the SSPO procedures actually were and the rationale for concluding that their numbers were bounding. But in general, I think it was discussed earlier today that human factors remains one of those areas that is something of a state-of-the-art issue.

CHAIRMAN APOSTOLAKIS: Human performance, not --

MR. NOWLEN: Human performance, yes. I'm sorry. And I think we fall there here. And, in particular, with regard to control room abandonment, our ability to really analyze those in detail is still an area of challenge for PRA. And I think that's reflected here, and so the answer is a bit mixed.

MEMBER POWERS: I guess -- I mean, what you've said is that it's a mixed bag for those that

have self-induced station blackout. What I was interested in was in those that -- the differences between those that do and those that don't in self-induced station blackout.

MR. NOWLEN: You can't really tell, because it's all wrapped up in the control room abandonment. And everyone tended to take fairly -- well, not everyone, but the majority of licensees took fairly simplistic approaches to conservative analysis of control room abandonment.

And so the distinction between SSPO and non-SSPO plants -- it gets washed out by the almost -- the relatively simplistic approach that people took to conservatively estimating control room abandonment contribution.

MEMBER POWERS: A lot of the text of the document speaks of these conservative analyses, and I was wondering, how do you know that they're conservative? Is it plausibility arguments?

MR. NOWLEN: Plausibility, the combined judgment of the Senior Review Board, the judgment of the reviewers. You know, for example, if someone took a one in 10 probability that a remote shutdown failed, we generally said that's probably conservative and we accepted it.