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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 10, 2008

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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554TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARD

(ACRS)

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THURSDAY

JULY 10, 2008

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., William J. Shack, Chairman, presiding.

COMMITTEE MEMBERS:

WILLIAM J. SHACK, Chairman

MARIO V. BONACA, Vice Chairman

GEORGE APOSTOLAKIS, Member

J. SAM ARMIJO, Member

SANJOY BANERJEE, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR., Member

COMMITTEE MEMBERS: (CONT.)

MICHAEL L. CORRADINI, Member

OTTO L. MAYNARD, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

JOHN D. SIEBER, Member

JOHN W. STETKAR, Member

A G E N D A

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

(8:29 a.m.)

CHAIRMAN SHACK: The meeting will now come to order. This is the second day of the 554th Meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following; status of NRC activities associated with seismic design issues at nuclear power plants, containment overpressure credit, future ACRS activities, and report of the Planning and Procedures Subcommittee, reconciliation of ACRS comments and recommendation, and preparation of ACRS reports.

A portion of the session on containment overpressure credit may be closed to protect proprietary information applicable to this matter. This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Tanny Santos is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's session. We have Mr. Royceman from National Legal Scholars law firm on the phone bridge line to listen to the discussion regarding the status of seismic design issues at nuclear power plants. To preclude interruption of the meeting, the phone line will be placed in a listen-in mode during the presentations and Committee discussion.

A transcript of portions of the meeting is being kept, and it is requested that speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

And our first item of business this morning is the status of NRC activities associated with seismic design issues, and Dr. Powers will be leading that discussion.

MEMBER POWERS: As the members are aware, the seismic issues have emerged in connection with early site permits and designs in the reactors. And there has been a substantial evolution in the overall assessment of the seismic hazard posed in Central and Eastern United States, so there's a lot of activities going on in connection with the seismic issue. And we were -- had the benefit of a little tutorial on some of the quantitative aspects of seismic hazard analysis.

(Off the record comments.)

MEMBER POWERS: At any rate, today we're

going to get a little more formal assessment of what the Staff's activities are. We have the benefit of a consultant, Bill Hinze, behind me, to assist us. He is actually an expert in this field, and will provide us some expert consultation to this discussion of a variety of different activities. I'm not exactly sure who's going to lead us off. Annie is going to lead us off.

Annie, the Committee is new, you're a bit new, and it is traditional when new people come and talk to us that they give some background for why they're qualified to talk before this esteemed body.

(Laughter.)

MEMBER POWERS: So if you would be kind enough to give us a little bit of your background.

MS. KAMMERER: Okay. Well, my name is Annie Kammerer. I'm, obviously, in the Office of Research.

(Off the record comments.)

MS. KAMMERER: Thank you. My name is Annie Kammerer, and I've been with the Agency for about a year and a half now. I came from an international design firm, Urban Partners International. It's based in London, and I worked for the London office, as well as San Francisco. I was working principally in liquified natural gas projects as a seismic hazard specialist, seismic engineer. My Ph.D. is actually in earthquake engineering from Berkeley, where I continued to do research, as well as the consulting before I came here. So I'm fairly new to the Agency.

When I came on, I was heavily involved in 1.208, the guide on seismic hazard, and was asked to sort of help develop and implement a research program on seismic, because at that time, the Agency was dealing with a lot of issues related to seismic as the ESPs were in-house, and Staff was grappling with a lot of different questions.

Okay. So I want to say thank you so much for having me here this morning. I really welcome the opportunity to show you all of the great things that we have been doing. You notice that my name is not on this slide, and that's because really this is collaborative. It's a collaborative project. The work is being done collaboratively. And, in fact, right now even the funding has been collaborative, with not only tremendous support from the management and the Office of Research, but also support from the Office of New Reactors in getting some of this work funded, because this is a new program. It basically got kicked off in 2007, and as you can see, we've developed the program really starting from 2008 and beyond. So a lot of times I'll be talking about the program plan, and this is what it is.

Okay. Great. Because there's so much in this program that we're getting going, it's really challenging to talk about it in 45 minutes too much, so I'm going to talk a lot about the philosophy and the approach that we're taking, as well as the items related to seismic hazard, which follows from what many of you heard on Tuesday. And, in fact, I've even taken some of the figures on Tuesday, and replaced my figures for the same item so that they'll look a little bit more familiar. So, hopefully, all of this will follow on.

So, again, we developed a research plan, and made it publicly available. And the reason for that was that there were so many different items. Those were all interrelated, which really needed a comprehensive, thoughtful process, that rather than doing each user need by user need, or research request by research request, we tried to put together a plan that would really give us a roadmap for moving forward so that it was clear what we were doing, where we were going, not only to us in-house, but also to industry, and to members of the seismic community who are very interested. And so this has now been published as of, I think, in January, but it is a living document. And as additional needs come up, we will do a periodic re-evaluation and republication of this document, probably about annually.

We targeted the program specifically on the regulatory needs of the Agency, of course. It's very important to understand RES is a service organization to the Agency, and what we need to do is to make sure that the needs of our folks in New Reactors, and NMSS, and NRR have the tools that they need, and the information that they need to undertake the regulatory activities. So this, as I mentioned, has been developed, really a lot of input, a lot of collaboration with the other offices, particularly NRO.

We presented the plan at a public meeting in December, where it was an industry meeting, and we've gotten really, really positive feedback from that. And, in fact, you'll see that actually EPRI has come in to collaborate with us on several projects, and I'll show you. So the NRC funding, and as well as DOE, so NRC funding is really being heavily leveraged in this program.

We are looking at both pushing forward the science, and really bringing the NRC's seismic research program to the cutting edge, as well as really looking at the items that will lead to long-term regulatory stability. So where are the big questions? We heard a lot on Tuesday about the uncertainties in a lot of these areas, and we really tried to target those areas in which uncertainty is the greatest in a very thoughtful way.

And, lastly, as you also heard, there's a movement towards performance state-based approaches, so this program deals with that a lot in relation to the design elements, which I'm not going to talk about today, but the engineering side of the program is very heavily based on the performance-based approaches in developing the technical basis for new regulatory guidance in that area. That's something that's really just getting in place now, and something that perhaps I can present to you in the future.

So we undertook this philosophy when developing the program. We wanted to look at both short and long-term research topics. We wanted to both address the critical needs that the Agency had in the short-term, but also look forward in a very thoughtful way to, again, reducing uncertainty, to increasing long-term regulatory stability, and to really getting us to the place where in five years we would want to be in five years, so that we didn't end up saying gosh, if only we would have done this back in 2009. We've really taken -

MEMBER POWERS: You're always going to do that.

(Laughter.)

MS. KAMMERER: That's probably true. Hopefully, we'll minimize the sleepless nights. I wish that I'd done different things last week, so that's very true.

We're looking at really a systematic and integrated program, and I hope that you'll see that as I present some of the specific topics. We're really trying to move the seismic research from a topic-by-topic approach to an integrated approach. And that's not only true within the Agency, that's true within the seismic hazard assessment community, but essentially Eastern U.S., in general. It's been more that people have been doing their particular topics as they could, and we're looking with other agencies to really bring an integrated approach.

We're focused on the highest uncertainties, and we're really trying to make everything that we're doing risk-informed, and fill in some gaps.

MEMBER CORRADINI: Just for my information. So what are other some key agencies that have been historically doing this? Are there one or two that stand out that you'd want to partner with so you can get information from them, and not duplicate what they're -

MS. KAMMERER: Absolutely. Well, the principal one with regard to seismic hazard is the USGS. Of course, they're responsible for the National Hazard Maps. They're also -- their core competency is going out and getting information on seismic sources, and so we're doing a lot of work. We're also, of course, leveraging DOE dollars quite a bit.

I'll show you one of the projects MJ East. We've actually managed to bring in partners also from the NEHRP program. The NEHRP Consortium is going to be partnering with us on that, and that's a group of USGS, NIST, FEMA, I'm forgetting an agency. Sorry if there's anyone here from the other NEHRP agency, there's four of them. So they're actually coming in and sponsoring with us. So I'll talk about a little bit about how we are actually bringing in other groups, because I think that is really critical to how we've been able to go from zero to 60, just even within a year, and fairly limited funding, of course, because this is a new program.

And we're trying to do a lot of things cost-effectively, and so that means piggy-backing on work that's been done that's very similar. There's been a lot of work out in California, doesn't necessarily apply to the CE U.S., but with a little bit of targeted funding, we can go to those people and say how about doing this small additional program. It's extremely cost-effective for us.

We're really trying to bring in universities. Grad students are cheap, they're much cheaper than lab folks on many occasions, and so we're -

MEMBER POWERS: But not nearly as good.

(Off the record comments.)

MS. KAMMERER: And in some cases, they're actually partnering together. We're just implementing some work now with Lawrence Berkeley Lab from some folks that moved from Lawrence Livermore.

MEMBER CORRADINI: I was hoping you were going to say labs are not allowed.

MS. KAMMERER: No, absolutely not. We definitely value the input from labs. So LBL is actually working with the University of California and bringing us a lot of great talent there.

MEMBER POWERS: Can we turn his microphone off? Go ahead, Annie.

MS. KAMMERER: You know, one of the things, too, is we're really trying to focus the work in universities in a way that is also looking at our future workforce, and trying to support the university work in an intelligent way to support some grad students, some post docs, and to really try to make sure that we have a staff, as well, and that they would love to come and work for the NRC, of course.

One of the things that we're also doing is what we call next generation approaches, and I'll talk about that in more detail. But it's sort of a new concept over the last few years within the seismic community, and so far it's been very successful in applying these types of approaches for our program. And, of course, we're always striving for the highest quality, and the best technical information.

So, hopefully, you'll recognize a few of these slides from Tuesday. And this is sort of an overview of the different elements within the program. So we're looking at all of the elements that go into the probabilistic seismic hazard assessment, so you'll recognize the sources, the information on how often the sources for these different types of earthquakes, the ground motion prediction equations which was okay, if there's this earthquake there, what does that mean for my site? We talked about that through this figure. Hopefully, it looks familiar. Again, getting a hazard curve. And then, ultimately, turning that into a response spectra, which becomes that blue curve if it's rock, or sometimes looking at site response, if that's important, in which case that comes from the blue curve.

We're also looking at the design and the engineering side of it, so it's really a two-part program. So we're also looking at seismic behavior, and degradation, and things like that for systems, structures, and components, as well as the full SSI, and support of some of the work ongoing with the certified design.

MEMBER CORRADINI: So not to go through it again, but just an overview question. If I were a chemical plant trying to site -- doing a hazard analysis for a chemical plant, or a biological facility that might have hazards, is the methodology identical?

MS. KAMMERER: Yes, absolutely. As I

mentioned, I come from liquified natural gas. And that was actually -- even though I hadn't worked in nuclear at all, it was really -- it's the same set of tools, and it's the same knowledge that you need to bring in.

I think the thing that really comes into play with nuclear is the very long return periods that we look at. In LNG, you tend to look at the 5,000-year event. Here we're looking all the way up to much longer return periods, and ultimately looking at core damage frequency, but the tools are the same. You would do this if it were a California hospital, or if it were an LNG facility. It's really just a matter of what your risk target is.

MEMBER CORRADINI: And the years that you go out, that's more regulatory policy versus -

MS. KAMMERER: Exactly. It comes down to acceptable risk, what is acceptable risk? That's sort of the beauty of a risk-informed performance-based approach, is you can make your decisions based on comparative risk. And even for things like multiple external events, it has to balance the design elements and where you put your money in the design of the plant.

MEMBER BANERJEE: So for the very long

term, do you have something that -- geological record that allows you to go out beyond 5,000 years?

MS. KAMMERER: Yes. On Tuesday, there was some presentation of that. And, actually, we're looking at some -- undertaking more in this project, as well. Like paleoliquefaction studies, paleoseismic studies, where you do the fault trenching, and you go through, and you can see where these different events occurred within time. There is some extrapolation, of course.

One of the challenges we have in the Central Eastern U.S. is that when you go to very long return periods, you have natural erosion processes, which will smear out the evidence of some of these events. And that's a challenge for us, and so we're having to really work with the USGS, as well as several universities that have been focused on this. Virginia Tech being one that we've just implemented a project with to look at exactly these types of questions. And certainly, Yucca Mountain -

MEMBER BANERJEE: The Ice Age must have made a difference. Right?

MS. KAMMERER: Of course. Of course. Especially to our tsunami program. Actually, that's where we're really building Ice Age issues. And we're also looking at supporting small pieces of funding or some peripheral concept studies for what we call naturally occurring seismoscope. Some of you through the Yucca Mountain work might be familiar with these precarious rocks, which you have this rock and it's sitting on this little tiny pedestal still, and so you can get some information about what could -- like an upper bound on the shaking because that rock is still there over a certain time period. So we're looking at actually doing a little bit of funding for some of these other ideas that people have that have been used in other parts of the world.

MEMBER CORRADINI: So let me just ask my question again, because I thought I understood, and I asked George, and maybe I've got it wrong. So when you say the return period in the chemical industry is 5,000 years, and in our's it's longer.

MS. KAMMERER: In LNG.

MEMBER CORRADINI: In LNG, it's 5,000 years. And now our's is longer. Is that because the risk here is lower, and I must look longer to accumulate my worry, or is it a policy issue, or is it the risk is higher, therefore, I have to look for longer periods. I want to understand the logic of the return period being different.

MS. KAMMERER: The difference is the criticality of the facility, and it is a question of what kind of risk is acceptable for different types of facilities.

MEMBER CORRADINI: So it's a value judgment and a policy. It's not a calculation. I don't come to a return period based on a calculation.

MS. KAMMERER: No.

MEMBER CORRADINI: I come to it based on judgment.

MS. KAMMERER: The hazard is what the hazard is. The earthquakes occur regardless of what's sitting there.

MR. AKE: This is John Ake. I'm also one of Annie's colleagues at the Office of Research. It's probably easier if we just table the discussion of return period. Think in terms of annual probability of exceedance, or annual frequency of exceedance. It makes it easier, because it doesn't imply -

UNIDENTIFIED SPEAKER: That doesn't change the question.

MEMBER POWERS: And there's a very simple answer to that. You take the consequences of an event -

MEMBER CORRADINI: That's right. You're

right.

MEMBER POWERS: -- by the return period to get to a value that has a figure of merit. And that should be roughly constant among all industrial activity.

MEMBER CORRADINI: Actually, you're -

MS. KAMMERER: But the design is different.

MEMBER POWERS: I bet you on a roughly based area, it's pretty darned constant.

MS. EWELL: Excuse me. Jennifer Ewell from Office of Research. Actually, Dr. Powers, can we let John go through the whole -

MEMBER POWERS: No.

MS. EWELL: -- history, because I think we're talking passed each other.

MEMBER POWERS: If he's going to deliver a presentation here, I want to get through Annie's.

MS. EWELL: No, no, no. He's going to answer the question briefly, but I think just if you give him 30 seconds, I think it will be clear.

MR. AKE: I just think it's easier to think in terms of annual frequency of exceedance rather than probability, because that is actually -- you're correct that that is what you multiply times the consequences -

MS. KAMMERER: Right. Right.

MR. AKE: But it's actually -- people think in terms of when they talk about return periods, they think well, I must need to wait 5,000 years to see that. It's actually annual, you have a one in five thousand chance -

MEMBER POWERS: You cannot tell me that you believe this Committee is so foolish that they will make that kind of a mistake.

MS. EWELL: Actually, we were just trying to answer the question, not meaning to insult anybody's intelligence. But it is a public meeting, and it's on record, so we thought that it would be nice to just get -

MR. AKE: Thank you.

MEMBER POWERS: Okay.

MS. KAMMERER: I apologize because sometimes I simplify things. At my last job, I was often the person who was trying to explain to the public in New York why they were spending their hard-earned tax dollars to seismically upgrade that Tappan Zee Bridge, for example, and so sometimes I do make some simplifications.

CHAIRMAN SHACK: We just like frequency of exceedance better than a time period.

MS. KAMMERER: Okay. Thank you. Also, there is, of course, the design. The design -

MEMBER POWERS: It's really complicated to make the conversion.

MS. KAMMERER: That's true. The design also plays into the risk, and that's a key element of performance-based engineering, and the thing that we're looking at in the design portion, which we're not going to be talking about.

MEMBER BANERJEE: So as you go out to very low frequencies, the uncertainties increase enormously, don't they?

MS. KAMMERER: Yes.

MEMBER BANERJEE: So how does one band that uncertainty?

MS. KAMMERER: Well, a little bit later when I'll talk about the SSHAC methodology, I'll explain how we're looking at quantifying that in the program. Okay.

UNIDENTIFIED SPEAKER: What happened to the tutorial, Sanjoy?

MEMBER BANERJEE: I did come to the first part, and then I had to go away.

MS. EWELL: Can we just try to focus on

the presentation, as we go through the presentation.

MEMBER POWERS: Jennifer, I'll tell you what, why don't you let me control the session?

MS. EWELL: I was just trying to -

MEMBER POWERS: Yes. Let me try to control the session.

MS. EWELL: Well, I don't mean to be a problem. I was just trying to help Annie get through the next slide, because I think some of the questions will come out in the presentation. I apologize, Dr. Powers.

MS. KAMMERER: And, of course, you all know where I work, so if you have any questions, I'm very happy to come back, and any of you are also welcome. I have an open cube policy for ACRS. So I think this is the way that I sort of use to explain that. Again, we tried to really develop a very strong integrative program, but we also -- so we separate it out in the different chapters, and so you can really think of our Earth Science and National Hazard section as being Chapter 2, again in the public document. Earthquake in Chapter 3. Chapter 4 is International Activities. We have a lot of stuff going on there. It's really too much to get into today, key things, of course, being the Kashiwazaki Lessons Learned project that we're undertaking through IAEA.

I've been to the plant twice now, and it's been extremely useful to be working on that program, as well as some tsunami work we're also doing with the Japanese, which will really help to inform our program. And the regulatory guides. Of course, all of this has to feed back into the next generation of regulatory guides, they're ongoing.

Just to give you an idea, this really is an integrated multi-disciplinary project. Each of these are one of the sections, and one of the topics of interest within the plan, and so you can see that they're really all over. And a lot of times we do have this cross-disciplinary work that we're focusing on.

We also are looking at, again, short and long-term planning. This shows some of the active projects that we have ongoing. As I mentioned to you, this is a very new program, but we've had tremendous support from the Office of Research to get this going. I mean, coming from the outside, I'm just amazed at the leadership and the vision, as well as the tremendous support from NRO in getting some of these implemented in 2008, which is really, really important. So we also have some that we're getting started. A few of these are awaiting some outputs of other things, so it's really critical that we try and keep this program on track. Research has been ongoing.

MEMBER APOSTOLAKIS: Yes. I mean, this issue has been very popular with this Agency for several years.

MS. KAMMERER: That's true.

MEMBER APOSTOLAKIS: Some of this stuff was developed with -

MS. KAMMERER: Absolutely. I think that there was -- this is really a way to take what has been done, because there were a few projects which were ongoing, to try and identify the gaps, and try to identify how it all would really fit together in a comprehensive way. So there were individual projects which were ongoing, that was true. I think what we've really tried to do - and, again, this is really -- there was a lot of vision in management across the Agency, that they wanted something where there was really a clear path forward, and a clear program. And the funding has actually gone up significantly over the last year, from about -- well, too little to a lot more.

(Simultaneous speech.)

MS. KAMMERER: It's gone from way too little to halfway to where I would actually really love to be.

MEMBER CORRADINI: You're eventually going to give us those numbers?

MS. KAMMERER: I don't know if I can in a public meeting.

MEMBER POWERS: And we have no need for those numbers.

MS. KAMMERER: I'd be happy to tell you in private, any of you, how much I really would actually love to have.

(Laughter.)

MS. KAMMERER: I'm not shy about asking for money, as many people know. Okay. So one of the things that we were trying to do is really to bring in this idea of these next generation approaches into the seismic hazard work, in particular. This is something that's been happening very -- it happened very effectively on a couple of projects, and we're trying to bring in the idea. And so far, it's been really, really effective for us.

As you mentioned, NRC has initiated a lot of the early seismic hazard work. When I was going to Berkeley, NRC was sort of spoken of with such love and nostalgia, I cannot even tell you. It's part of the reason I came, was because so much of the really key work came from this Agency.

Really, different methods and tools kind of took off. A lot of different databases were developed. A lot, unfortunately, ended up in gray literature, proprietary reports and proprietary software. So now that the field is maturing, there's a real push to bring it all back together and to integrate it, not only in this Agency, but within the community, and so we've really, I think, been able to inspire a lot of the community to get on board with us as we're trying to do this. And the way to do it is through common databases. Get everyone in the room to bring their data for the benefit of all, community consensus, documentation of thought process is very, very important for letting everyone understand exactly how people came to these decisions.

That leads to long-term regulatory stability. If you understand what went into their decision making, when new information comes up, you can put it in some sort of framework. Does this fit with the technical ideas and the framework people had when they made these decisions, or is this really something new? And, of course, it helps us to better quantify uncertainties, particularly epistemic uncertainties, and better understand where they lie.

MEMBER POWERS: Is your perception the same as mine, that when we were looking at the seismic sources to Vogtle, that a lot of that was just because of confusion over databases, and sources, and things like that?

MS. KAMMERER: I don't -- I think that that's really -- questions on Vogtle really should be addressed to NRO. I was not in -

MEMBER POWERS: I asked you. (Laughter.)

MS. KAMMERER: I think that in general, one of the things that we're trying to do - and you'll see this especially in the Central Eastern CEUS SSC project, which many NRC staff are involved with. EPRI and DOE are funding it. Dr. Shack is - excuse me - Dr. Hinze is helping us to work on this program, because a lot of what we had was possibly out of date. The databases that we had were out of date. There was this mix of things that were still completely appropriate, and things that were out of date. And I think it's just -- it was a challenge. You had a lot of different vintages of information, so call that confusion. I'm not sure. I think our staff has done a tremendous job.

UNIDENTIFIED SPEAKER: Maybe you could rephrase -- I wasn't sure I understood your -

MEMBER POWERS: I'm not sure that's a real important point.

UNIDENTIFIED SPEAKER: I mean, what Annie is talking about, a lot of these source models for the Central Eastern U.S. were developed in the mid-1980s, but they have updated with the ESPs and the cause, they have updated several key source zones. And you saw that with Vogtle, and our ongoing work is to do a complete update of the whole Central Eastern U.S., which is what Annie is going to talk about.

MS. KAMMERER: Right.

MEMBER CORRADINI: So, again, for a novice, as you look harder do you find that the source frequency magnitudes are growing in terms of what was there, and now as you look harder, you find more, or are you finding that you just are getting smarter on how you analyze it? I'm trying to understand.

MS. KAMMERER: Mostly, it's the -- I think we're getting a lot smarter, certainly. And a lot of work has been done in the interim 20 years. In some cases, yes, we have found new information, and we have looked harder. When I talked about the CEUS SSC project, that is based on all of the data as it exists now. Just really pulling together everything that's there, including information from the application. But also, in conjunction with that, we really want to start doing some of this work that will help us to identify when we might have missed things, or where we could better characterize sources, for example, is Tennessee.

MEMBER POWERS: And one of the problems you suffer from is, of course, you're an active researcher in this area, and so you're very up-to-date.

MS. KAMMERER: Yes.

MEMBER POWERS: Some of the Committee are probably not as up-to-date. It might be useful to comment on changes that have occurred in USGS assessment on the return frequencies. For instance, at the New Madrid site, and some of the other major seismic centers, where they're probably not -- are very familiar with the pre-1989, maybe not so much familiar with the post 1989.

MS. KAMMERER: Right. Well, we do have National Hazard Map, which is ongoing, the work is ongoing. So they redo this map every six years. There are, of course, changes. I guess over the last 20 years I would say that a lot of it's gone up. The most recent maps of several areas have actually gone down, and the reason for that is because of the new ground motion prediction equations. We have more data, and I'll talk about that a little bit.

One of the key -- all of this plays together, so it's -

MEMBER APOSTOLAKIS: In the same school. When you use acronyms, explain what they are, CEUS?

MS. KAMMERER: Okay. Central Eastern U.S. It's actually on some of my later slides.

(Off the record comment.)

MEMBER APOSTOLAKIS: Are you going to tell us exactly what that means?

MS. KAMMERER: Yes, well I hope to. I've only got 10:00, so -

MEMBER POWERS: Yes, we could let her go.

MEMBER APOSTOLAKIS: If we don't understand what she's saying, that doesn't help.

MS. KAMMERER: No, I know, but I think it will be clear when we look at the -- when we look at the actual projects, I think it will be clear.

MEMBER APOSTOLAKIS: Okay.

MS. KAMMERER: Because where that term comes from, the next generation attenuation relationships, which we're piggybacking on.

MEMBER APOSTOLAKIS: On the information -

MS. KAMMERER: Yes. Well, it doesn't apply to next generation. The approach is considered next generation, but it's been applied to attenuation relationships in particular with great success, but it really implies a fundamental redevelopment of these tools, not just this incremental change, not where we're going to take what already exists and just weight it differently. We're talking about developing new tools, really take it to the next level, and bringing the work in the Central Eastern U.S. and the hazards, the understanding of hazard in the Central Eastern U.S. to the same level as the west, where a lot of this work has been focused.

MEMBER APOSTOLAKIS: You are taking for granted that plants should follow a probabilistic approach, and from what little I have read, there are some people especially to do it, who object.

MS. KAMMERER: That's true.

MEMBER APOSTOLAKIS: Are we going to understand at some point, today or maybe some other time, what the objections are, and why this Agency decided to go -

MS. KAMMERER: Well, I'm not sure that -- I don't know that that's within this, but I will actually talk about what we're doing to address that discrepancy with Europe.

MEMBER APOSTOLAKIS: Okay.

MS. KAMMERER: So it's more of a technique, rather than getting into the nitty-gritty of the details. But you'll see, we actually have some ideas on that, and so we'll talk about that. And, certainly, the international program that we're doing is something. In addition, IAEA is about to update their seismic hazard guide, and that is, in large part, to members of the international community in different countries saying that they want our 1.208 incorporated more, and also some of this information that's coming out of our project, the guidelines. People are really asking for this, so I think that the tide is turning with regard to the disagreement.

MEMBER APOSTOLAKIS: But we should understand the disagreement. I mean, as a Committee we should understand it.

MS. KAMMERER: We can that in a separate -- that's really a large -

MEMBER POWERS: I think it's fair to say, George, that this is not a -

MEMBER APOSTOLAKIS: Not for today.

MS. KAMMERER: Right. That's certainly

something that we can talk about.

MR. CHOKSHI: This is Nilesh Chokshi. I think, George, there was a recent meeting with IAEA about bringing different countries and use of the probabilistic methods, and at some point in time we can tell you what is the outcome of that.

MS. KAMMERER: Yes.

MEMBER APOSTOLAKIS: Yes, I'd like to hear that. I don't know if the other members want to.

(Chorus of yeses.)

MS. KAMMERER: I think it would be very useful. And we have a lot of activity going to try and bridge that gap with the rest of the -- not bridge the gap, actually, because many people -- most countries want to move towards probabilistic risk-informed techniques, and they would like our leadership on that, which is great.

So I'm going to talk about some of the stuff again that we have with regard to the hazards portion of it, not get into, unfortunately, design. We just really can't get to that today, but some of the things we have going, maximum magnitude of the CESSSE project. I'll talk about all these, and we do have a small study with the USGS to look at the National Hazard Map, so you go look at a variety of different assumptions, and to try to understand the sensitivity of their map to some of the things that we would maybe do differently, or we aren't really sure about. And we're looking at uncertainties that will help us prioritize some of our research needs. Again, I'll talk about Next Generation East project, and the project of the application of the SSHAC guidelines.

So just to remind you of this figure from a couple of days ago, what I'm going to talk about next is these curves, which say for this earthquake of magnitude and distance, this is what it means to my site. This is how much the shaking is. And just to remind you what was said, these are empirical relationship principally, and in the East there's going to be some modeling, as well, but there is some scatter here. So what we're looking at is really not only trying to get the best estimate, but also understand the expert -- so just to remind you of that slide.

So the way that we're doing that is through a project called NGA-East. This is a follow-up project to a very successful project called the Next Generation Attenuation project for the West, which significantly reduced the scatter in the different relationships. It took all of these different attenuation relationships, our ground motion prediction equations, the terminology has changed. They're the same thing. So it went really from all of these different separate relationships that everybody had to bring a unified to approach, and that was because they had mutually agreed upon databases. Everyone brought their data together and agreed upon it, and did baseline correcting, things like that.

They agreed upon the technical bases. They worked together to figure out what the appropriate assumptions would be in some of the work. The upshot is the epistemic uncertainties, the modeling uncertainties were really reduced, and they were characterized. And, as a result, there has been broad community consensus in the West. I mean, really overnight these became the standard of practice. So you'll notice that this is sort of before, and then after. And you'll notice that actually in many cases the numbers actually came down. And that was due to finally getting some near-field large earthquake data. Before it was simply extrapolated out, now we actually have more data, and the same is true with the East.

MEMBER APOSTOLAKIS: These curves don't display uncertainty.

MS. KAMMERER: These curves do not. No,

these are all just the medium curves. However, again, it's that curve, it's a curve, it's not a single value.

MEMBER BLEY: Did any of this work, and I'm trying to account for things in the modeling, actually reduce the uncertainty or scatter?

MS. KAMMERER: Well, the -

MEMBER BLEY: That's strictly, that's the measured data.

MS. KAMMERER: It's the measured data. What they did was they were able to really pull together a much larger database.

MEMBER BLEY: Okay.

MS. KAMMERER: They pulled in data from Japan, as well, to look at that. It reduced some of the scatter in the models, and that some of the assumptions that you have to make which are tied to that data were -- they developed a technical basis for deciding what those assumptions should be.

So we saw this, while I was in California working at the time, and saw just overnight that all of these disagreements on so many projects I was working on evaporated. All of a sudden everyone said we believe in this process. It had broad community support. And, again, the approaches they took, agreed upon assumptions, a common database at very high levels, everyone's data was pulled together. And for the East we're doing the same thing.

The way that we approached this, because we felt that this was of benefit to so many different agencies, that if we put a small development program in place to develop the scope, the schedule, the budget, and maybe to do a little bit of PR, that we could leverage NRC funds significantly. We're now at the end of this process. We've had three workshops, and we're getting to kick off the main project, and it's been very, very successful. So, in total, it's a five year, $4.3 million project. We're looking at coming in with a million and a half of that. DOE is going to match our funds. EPRI is coming in hopefully with about a half a million, possibly. And also, the other NEHRP agencies are also partnering with us so that's a consortium again of FEMA, USGS, NIST. And NIST even hosted our second workshop which was a stakeholders workshop here in D.C.

MEMBER APOSTOLAKIS: What is NEHRP?

MS. KAMMERER: NEHRP is the National Earthquake Hazards Reduction Program. It's a program that's been set in place, and it's a way for different agencies that are involved in that to all work together. And, in addition, we're even seeing small pots of private funding from Risk Management Solutions and other groups.

This is being run through the Pacific Earthquake Engineering Research Center at Berkeley, which is where the original program was done. They had all the contracts in place. They had the experience, and it's just worked really, really nice. USGS is also coming in with in-kind participation, and this will be used for the next generation of National Hazard Maps.

Okay. So that's the ground motion prediction portion of the problem. Then there's also the sort of broad guidelines of how do you undertake these studies? And, of course, many of you are very familiar. In fact, some of you are even involved in writing the guidelines which are commonly now known as the SSHAC Guideline, the Senior Seismic Hazard Analysis Committee developed a NUREG. This is internationally. I was really quite surprised when I started doing some work. This has sort of become the constitution at PSHA. And really now, it's sort of this framework, and now they're saying we want to use this. There have been a few of these projects undertaken with these guidelines. Give us some practical laws to sort of help us work through.

MEMBER APOSTOLAKIS: We've had a problem with this agency, and I'm glad you're saying these things. We're doing better outside than inside.

(Simultaneous speech.)

MEMBER APOSTOLAKIS: One of those letters recommended that some effort be undertaken to make sure that various groups within the Agency use more or less the same approach to the expert opinion and dissertation.

MS. KAMMERER: Yes.

MEMBER APOSTOLAKIS: You are working with all these other agencies. Is it harder to work with our own people here?

(Off mic comment.)

MS. KAMMERER: There have been some challenges. I think it depends on who you work with. I mean, I think that -

MEMBER APOSTOLAKIS: But it shouldn't. That's my point.

MS. KAMMERER: Yes, I know. The seismic group I think has been -- I mean, we really think of ourselves as the seismic team, and we meet for lunches, we talk, we have share point sites that we communicate constantly. So I think that we have been

-- I feel like I've just been incredibly fortunate to have such great people across the Agency to work with.

You know, there are definitely some challenges. I'm also the Chair of the Flood Technical Advisory Group, but there are challenges. But, boy, you're right. I mean, the international community love the NRC. I can't tell you. You walk into the room as the NRC person, and it's taken for granted that you're doing good technical work, which is just -- it's amazing.

So getting back to this, the general framework works very well. Everyone agrees on that. No one wants to touch the SSHAC Guidelines. What people want is more details. How are you going to do this? So we put together this set of workshops that bring in people who have actually tried to use the guidelines to say what worked, what didn't work. And, particularly, we've brought in people from the Swiss program, SSHAC Level 4, which has been the cause of a lot of international consternation. And, as well, people that worked on the Yucca Mountain project.

This was an NRC-funded project, but actually to bring in the international participants, which was challenging for us, the DOE Extreme Ground Motions program actually sponsored their participation, as well, because they felt it was important.

MEMBER BANERJEE: What do you mean by Level 4?

MS. KAMMERER: The SSHAC Guidelines describe a series of levels of complexity that you can undertake, coming from like the single individual trying to characterize the community, the breadth of community opinion, all the way up to where you develop a Level 4, which is individual teams of experts coming to their own decision trees, and then trying to bring it together, so it's sort of these levels of complexity, Level 4 being the top level. The Swiss said well, NRC Level 4, that's what we want, and so that's what they did.

We are actually using this process for the Central Eastern U.S., and we're doing a Level 3, because it's cheaper, it's faster. We felt that we have the understanding to really get the same product at the end. It's just going to be a lot more work for the people involved, so it's a series of levels in complexity.

MR. CHOKSHI: This is Nilesh Chokshi, again. Just to answer your question, the four level -- the levels you decide based on the nature of the facility, how critical facility is, like the nuclear facilities, things like this. What state setting you are talking about really is called seismotechtron, it can warn into -- in a very active area, so depending on the nature of the questions, the scope of the study, the particular aspects, you decide what level.

MS. KAMMERER: What you need.

MR. CHOKSHI: For nuclear presently, this is generally three and four.

MS. KAMMERER: Yes.

MEMBER APOSTOLAKIS: Yes. The issue, Sanjoy, was that typically researchers working on these things, they try to do the best job they can, and they scare the hell out of people who don't have such a major project. And they say you're telling me I have to invite international experts and train them and so on. All I have to do is pick up the phone and ask a couple of guys, and I get an idea, and I solve my problem. If the problem is not of major significance, the nation, for example, like Yucca Mountain is, maybe that's good enough. It's not very controversial, so they were very careful to say here are four categories, and under these circumstances you really don't have to try to do this Cadillac, so to speak, approach, which is very expensive. Because there have been other projects, in fact, PGME, one of the guys who was on the committee said look, I had these problems, and I didn't go through all this. I invited some of the good people I know, we exchanged ideas and so on, and it worked. So that was a -

MEMBER BANERJEE: But this guidance has formalized this work -

MS. KAMMERER: Yes. And we're trying to fill in the details as to how do you achieve these different levels.

MEMBER BANERJEE: I've got the picture. I think we can move on.

MEMBER CORRADINI: So just so I understand. If you look at NUREG-1150, what level would it be similar to?

MR. CHOKSHI: I think it will depend under which part of the 1150 you're looking at.

MEMBER APOSTOLAKIS: I mean, the severe accidents, they invited people to Albuquerque, they trained them, they spent time making sure they understand. They went back home, they come back. I mean, that's as expensive as it gets.

MS. KAMMERER: Well, hopefully these things will be done -

UNIDENTIFIED SPEAKER: We have to keep

moving.

MS. KAMMERER: Yes. Okay. So what we did is we had a series of workshops which were facilitated by the USGS, and we focused on three areas; the first one, Lessons Learned, what went right, what went wrong, what can we learn of it? What are your thoughts? All of these people who had participated, and it was focused on process, only process.

The second question, which was key to, of course, how long do you update these things? How old does the old EPRI site have to be before it really needs to be updated? This was a question that not only we're grappling with now, but by looking at it, it helps us to set the ground rules for what happens once the CEUS SSC project is completed, and we have a replacement. And then, also, understanding and characterizing uncertainties is something that we want to do in the future, in an additional -

MEMBER BANERJEE: My question originally, how do you go about doing that?

MS. KAMMERER: Well, there's a variety - I'll talk about that in the CEUS SSC project.

MEMBER BANERJEE: Okay. If you're going to talk about it later, fine.

MS. KAMMERER: Yes. I'll get there one.

One more product, and then we'll get there. So the goal of this is in the short-term, we're going to have USGS open file report summarizing all of the discussions. At the last workshop, we basically came through with a series of concrete recommendations that everyone that was in this workshop agreed upon, mutually agreed upon by sort of many of the best and the brightest.

And, by the way, ACRS sent staffers to the second workshop on how and when to update, and we really appreciate that. NRO has also sent staff, as well, so we've had good representation across the agency. Ultimately, we'll turn this into a NUREG document which will be a companion to the SSHAC Guidelines.

MEMBER APOSTOLAKIS: Is it just -- or the meetings are when the ACRS meeting here?

MS. KAMMERER: Yes.

MEMBER APOSTOLAKIS: Some of us cannot go to places -

(Laughter.)

UNIDENTIFIED SPEAKER: It's very deliberately done, George.

MS. KAMMERER: Yes. Trying to get the girth of people that we were trying to get in the room was just painful, but I don't have to tell you guys. I'm sure you know.

Okay. So this Central Eastern U.S. Seismic Source Characterization project for nuclear facilities, the CEUS SSC. This is a major study of participation from NRC, being principally led by EPRI. It's a complete replacement of the EPRI SOG database, if that makes sense. So it's being half funded by EPRI, and half funded by government.

USGS is also participating under sponsorship from NRC, specifically. Some of the funding NRO sent over is supporting that participation. Other U.S. specialists, Dr. Hinze, is on the participatory peer review panel, as well as two of us in RES. We have participation from NRO in several different overview, so that the idea is that we have oversight and participation all the way through this project, so that what we get at the end we feel is really as good as we could get it. And we're happy with the project that comes out at the end. USGS also has people on the peer review, as well as bringing in a lot of technical expertise for this.

MEMBER ARMIJO: Who is the Project Manager? Is it EPRI, project managing?

MS. KAMMERER: EPRI is project managing.

MEMBER ARMIJO: Right. Right.

MS. KAMMERER: That's right. And this was something that staff really kind of pushed for, and we're thrilled that they've taken this on. And I was a little skeptical at first, I think many of you, we talked off-line, in really how much of a say the NRC was going to have going along, but so far I think it's going very, very well. I feel very positive about the way that it's headed.

MR. HINZE: Annie, I don't -- if I may interrupt for just a moment. I think Lawrence Salimony from Savannah River is a major project manager of this.

MS. KAMMERER: That's true.

MR. HINZE: From a technical standpoint, and I think that may be what you're getting at.

MEMBER ARMIJO: Yes. Who is going to make sure that this thing meets its goals, gets -- somebody's got to be in charge.

MS. KAMMERER: Well, yes, that's true. And programmatically, that's true. With regard to making sure technically that it meets its goals, that's really, I think, a key role of the participatory peer review panel, where we have participation from three folks, USGS, as well as Jeff

Kimble.

MEMBER APOSTOLAKIS: Directed the term participatory peer review also from SSHAC.

MS. KAMMERER: That's right. This is based on -- this follows the SSHAC Guidelines very, very closely. And, by the way, EPRI has produced a report describing exactly how this is going to happen. There's a document which is now publicly available, I think just a few days ago, forms the basis of their proposal to DOE, and their agreement with DOE. It literally just came out, and so you can all see exactly how this is going to work. And it really, though, has to be tied with the SSHAC Guidelines, so the way that -- the goal of any SSHAC process is to try to bring in the breadth of community opinion to look at all of the possible hypothetical alternate models, to have workshops that bring in the proponents of these different models, to listen to them, and to develop in the end a database or a decision tree which takes all of these viable alternate hypotheses into account and appropriately weights them. And that's done by an integration, but there's this participatory peer review panel which really tries to hold that team to the fire, and say I don't think that you've appropriately given this enough thought, and ask a question of the expert. So this really is a very formalized process.

So as this project is undertaken, one of the first things to do is develop a massive database of all of the existing information that could be brought to bear to answer the question of what is going on tectonically in the Central and Eastern U.S., and what are the capabilities of these different sources? That's a key part of all of this. And so that provides some information on the aleatory variability of the different sources, so what is the variability of how these sources behave?

As you go through and you look at all of these different alternate hypotheses and you weight them, that gives you a quantification of the modeling uncertainty, the epistemic. And so, it's a very rigorous formalized process that gets you quantitative realizations of these different types of uncertainties, which represent the community, the breadth of community opinion at the time the study is done.

MEMBER APOSTOLAKIS: Ultimately, the quantification of uncertainty comes from experts using -- it's not just this is what I think. I mean, you have to document it. And it's important, too. I mean, it is not a coincidence that the title of the report, Guidance on Uncertainty and Use of Experts. The Committee deliberately put these words up there to point out that -- because at that time the big question was why are the EPRI curves different from the Livermore curves? And the Committee decided it was not really something fundamentally technical, but it was how things were interpreted, judgments were elicited, so the title itself included the words "Use of Experts". Because it's model uncertainty, any time you have model uncertainty, you've to actually go to experts to interpret the uncertainty. It's not a statistical kind of thing where you collect data, and you -

MS. KAMMERER: Right.

MEMBER BANERJEE: They just don't have enough data, I guess.

MEMBER APOSTOLAKIS: Especially at that time, I don't know what it is now.

MEMBER POWERS: Annie, I do not know how you and the Staff plans to break down its activities, but I've got lots of view graphs on lots of topics, so I don't know how long you're supposed to go.

MS. KAMMERER: Well, I was supposed to stop 15 minutes ago, so let me get to one really, I think, key -- oh, let just mention -- give me two minutes, and as long as there's no more questions, I think I can just summarize everything.

With this, one of the things that has come out is people want to go to the probabilistic method, but they don't really quite understand how they go about that. One of the things that came up at the first meeting that we are now implementing is an international observer's program. We're basically inviting people who want to be involved, or are seismic hazard specialists in the other parts of the world that might not think that they want to go probabilistic, to come and watch us go through this process, and see that it does, indeed, have a very strong technical basis, and to see how they can implement it in their country. So we have a number of participants from different countries coming to these workshops as observers. And we're also the day before doing sort of an orientation training session on what is going to happen. And we really hope that that will allay a lot of the discussions and the concerns which are not always necessarily based directly. So, as I mentioned, we want to do some work. We're just getting some work started, and getting new information in the Central Eastern U.S., this is being coordinated. We're looking at maximum magnitude again through a workshop, a community consensus approach, trying to bring everybody in, bring everybody's data together, and work from a community approach.

So I guess, let me just say that we really feel very strongly that we're really headed in the right direction. And I'm just amazed at how much we've been able to get going within a year. So between the CEUS SSC, which is going to give us new sorts of characterization for the Central Eastern U.S., and ongoing work to continue to dig into some of these regions.

The Ground Motion Prediction Equations which say okay, for those sources visit means my site, which is being addressed through NGA-East, and all this within the process, again, of the SSHAC Guidelines. This is really bringing us to the next generation of seismic hazard characterization for the Central Eastern U.S., and we believe will bring us to a place where we're going to have long-term regulatory stability, and an approach that everyone understands, and buys into, and is really not only NRC, and industry, and DOE, but really a community consensus.

So I think I'm just going to go ahead and skip that. Mentioned that tsunami is also part of our program, very close to my heart.

MEMBER POWERS: And you notice the Committee gave you a big attaboy for that.

MS. KAMMERER: Thank you. I really appreciate that. I really, really appreciate that. I think we have tremendous -- we've had a lot of really great interaction within the Agency, and also with the other agencies that were partnering with the USGS Woods Hole group, and NOAA.

MEMBER POWERS: I think what you did there was very well done, and we brought it up in our research report.

MS. KAMMERER: Thank you. Yes, I really appreciate that. And I've got to hand it to RES Management. They have been incredibly supportive in getting this done. And those -

MEMBER POWERS: Must be merit of you telling us -

MS. KAMMERER: No, I mean, I feel like as a researcher, I feel like I've died and gone to heaven having all of this great -- it's like a really smart thing we should be doing. Okay, go do it.

MEMBER APOSTOLAKIS: One of the controversial issues in the elicitation and utilization of expert opinions is how do you handle the different views of, in the old days, the different experts, and the issue of relative weight. And, of course, the NRC had directed Livermore to give equal weight, which shocked the Committee. Then we came up with this approach of having multiple workshops, and bringing everybody to the same level, and then you don't need outside -

MS. KAMMERER: Right. Right.

MEMBER APOSTOLAKIS: However, there are still people who believe that this is an assumption, really. I mean, you can't prove, but since you have these workshops, eventually everybody will be the same.

MS. KAMMERER: That's right. And, certainly, people are -

MEMBER APOSTOLAKIS: Are you guys addressing this issue?

MS. KAMMERER: Yes, absolutely. That's one of the key questions that have come up in these workshops. Absolutely. And a lot of times they actually have ended up with equal weight. And, by the way, one of the things we're trying to do in all this is avoid another EPRI-Livermore disagreement. That's why we're trying so hard to work together, and to bring USGS in, because, of course, they do have the national model, as well, so we're really trying to bring this all together. What we're trying to do is be smart from the very beginning, so we don't end up in an uncomfortable place at the end.

I think what we're trying to do very hard is to really -- of course, people are all going to disagree. One of the two things that came up - actually, three things came up - one is that bringing people back together to discuss why they're making the decisions they're making, and what their assumptions are. These are the experts. One of the things that we found in the past is they tried to keep them all separate and keep them pure, but, actually, that assumes that experts can't learn by talking to each other. And, so, one of the things that has come out is we need to bring everybody back together, after there's all of these different weights of things, and say why are you doing this? Why are you doing that? Having to question each other, and, hopefully, that will lead to better consensus about how the weighting should be.

Of course, everybody is going to think that their approach deserves the higher weight with regard to the experts, but really that comes down to technical integration. And for this Level 3, it's a real strong need to have the participatory peer review panel really hold the integrator's feet to the fire, and ask them why they're doing that, and why they're weighting certain people. It all has to be tied back to that database, the technical information which is available.

MEMBER APOSTOLAKIS: So it is being addressed, and we don't have to -

MS. KAMMERER: Yes. Yes.

MR. CHOKSHI: George, I think the SSHAC concept of the expert is they're both as evaluator and expert for the -

MS. KAMMERER: That's right. And peer review.

MEMBER APOSTOLAKIS: I agree. I mean, the group proposed an approach. That doesn't mean that they are closer to scientific theory, proven thing.

MS. KAMMERER: Right.

MEMBER APOSTOLAKIS: And the point is that other groups - and, again, it comes back to why are people in groups within the NRC doing different things - but, as you know, there was a major study in the European Union regarding whatever - I don't care what they - but, anyway, they applied this approach of having numerical evaluations of the credibility of the experts. You asked a guy how high do you think the Eiffel Tower is, and then depending on that. And this minor controversy is still there. All I am asking is that you guys are addressing it, you don't have to discuss it now.

MS. KAMMERER: Yes. And I think you'll probably find the USGS open-file report very interesting. And I apologize that I -- because, of course, we did offer an invitation to come, but apparently it was -- all of our workshops are poorly timed.

MEMBER APOSTOLAKIS: It was the first week of the month. That's when we meet.

MEMBER POWERS: It seems to me, George, that -- I mean, Annie is a breath of fresh air here, and she -- I can listen to her for hours. We don't have hours.

MS. KAMMERER: Oh, thank you.

MEMBER POWERS: But it seems to me that there is an excellent opportunity for us to have a Subcommittee meeting.

MEMBER APOSTOLAKIS: Agreed.

MEMBER POWERS: Which we could go over this research program in some depth. And it seems to me the vehicle for that would be when you produce this

NUREG on the SSHAC Guidelines, that that would be an opportunity both look at the specifics, but also to look at the overall research program in some greater detail. And we could schedule that when George has classes, and -

MS. KAMMERER: (Laughing.) I would really welcome that opportunity.

MEMBER APOSTOLAKIS: I think probably we'd need a series of Subcommittees.

MEMBER POWERS: It is, indeed, and it's -- I mean, as we noted in the Research program, this whole area is being revitalized, justifiably so, because it's going to be -- seismic is going to be the risk-limiting factor, and so when we see people coming in with new reactors and telling us they have 10 to the minus 8 CDFs, we know that's just not true, when you locate them at any real site. We have major things, but that's my proposal, is that, Annie, once you get your SSHAC Guideline NUREG in shape where you think it can benefit from an examination by the Committee, that we would do that, but we would expand to look at the entire seismic -

MS. KAMMERER: That would be great. That would be great.

MEMBER APOSTOLAKIS: When do you think you may have it, roughly?

MS. KAMMERER: Oh, we're going to have them within the next couple of months. Right?

MR. AKE: The draft, I believe, is due in October -

THE REPORTER: Please come to a microphone.

MEMBER BANERJEE: You have to come to a mic.

MR. AKE: I believe the draft open-file report is due in October to us, is deliverable to us.

MEMBER APOSTOLAKIS: Our review can be participatory, too.

MS. KAMMERER: Absolutely. Absolutely. And, again, there's the open-file report, but in addition, we'd like to turn this into a NUREG, as well, because that -- and so really to take -- because we wouldn't want to hamper the community from saying what they wanted to say feeling like it's going into some sort of NRC document.

MEMBER APOSTOLAKIS: Oh, this is not the NUREG then.

MS. KAMMERER: It's a U.S. -- the draft that we're getting -- the product that we're getting from the USGS, as a result of these workshops is a

USGS open-file report. And that was done because we wanted people to feel like they could take away sort of the whole regulatory element of it, and really talk about the peer sides and the process. Although, obviously, the regulatory arm is everywhere.

MEMBER APOSTOLAKIS: We should meet before the NUREG.

MS. KAMMERER: Yes.

MEMBER APOSTOLAKIS: We can meet you as NUREGs, we cannot meet you as U.S. geological survey.

MS. EWELL: Oh, I would like to ask, though, that we have a little bit of time to just make sure we have a staff consensus, agency consensus before -

MEMBER POWERS: I mean, it's up to you guys when you do it, but that would be my proposal.

MEMBER APOSTOLAKIS: I think that's an excellent proposal, but we carry two -

MS. KAMMERER: Okay.

MEMBER APOSTOLAKIS: Don't give me three volumes and ask me to come in a week.

MS. KAMMERER: Hopefully, it's going to be nowhere near three volumes. I mean, we really wanted to be very focused on the recommendations.

MEMBER APOSTOLAKIS: Very good. Very

good.

MS. KAMMERER: Thank you so much for inviting me.

MEMBER POWERS: Thank you, Annie. There's more to come.

(Off the record comments.)

MR. STUTZKE: We're here to talk about Generic Issue 199, and I'll explain briefly what that issue is. I'm Marty Stutzke, the Senior Technical Advisor for Probabilistic Risk Assessment Technologies. I work in the Division of Risk Analysis in the Office of Research. Sitting next to me is Dr. John Ake, who's in the Division of Engineering, and also in the Office of Research. Sitting over at the side table is Lauren Killian, who's the Project Manager for Generic Issue 199.

And to anticipate one of George's comments, if you flip to the last page of my presentation, all of my acronyms are spelled out.

CHAIRMAN SHACK: Actually, we forgot a couple.

MR. STUTZKE: Well, I did notice that NRC was not on there.

MEMBER APOSTOLAKIS: What's the difference between a GSI and a GI?

UNIDENTIFIED SPEAKER: One is a -

MEMBER APOSTOLAKIS: Oh, come on. The other is what, a scientific issue? Oh, I'm glad you do not know. I thought it was -

MR. STUTZKE: John Kaufman should probably answer that.

(Off the record comments.)

MR. KAUFMAN: John Kaufman, Branch Chief for the Generic Issues Program, acting today for Jack Foster. There's really no difference.

MEMBER APOSTOLAKIS: Oh, okay.

MR. KAUFMAN: They're the same.

MEMBER APOSTOLAKIS: Oh, so you just decided to go -

MEMBER POWERS: Now, that's something I would never want on the record, be a member of the Agency list and say drop safety, which is a good idea.

(Off the record comments.)

MEMBER APOSTOLAKIS: Shall we start, Marty?

MR. STUTZKE: Yes, please. Okay. Briefly, the issue is as follows. The Staff has identified the estimated seismic hazard levels at some plants in the Central and Eastern United States may be higher than we previously thought. We know this because we've looked at the Early Site Permit applications, and made some comparisons to the IPEEE. We also have the benefit of looking at U.S. geological survey seismic hazards, too.

The next slide gives you an idea of our problem. These are respond spectras, the safe shutdown earthquake being in black, at a low ground motion response spectra you'll see that your envelope is bounded, which implies everything is okay. Some of the more recent seismic estimates more like a solid red line, and you can see the high frequency portion exceeds the design spec. Okay? So it's not just that the frequency or the exceedance frequencies of earthquakes may be increasing, but it's the spectral composition is also changing. And the problem we're faced with is what does it mean?

MEMBER APOSTOLAKIS: What's GMRS again?

MR. STUTZKE: Ground Motion Response Spectra.

MEMBER CORRADINI: That is what the plant base will see.

MR. STUTZKE: Right.

MEMBER CORRADINI: That's after point source manipulated to get to the final point of what's wiggling.

MR. STUTZKE: That's right.

MEMBER CORRADINI: So what's wiggling the base. Got it.

MR. STUTZKE: So the low frequency is going down.

MEMBER ARMIJO: What you just said was a different thing. Right?

MEMBER CORRADINI: It's what the plant foundation would see.

MEMBER RAY: Well, that means you're taking into account soil structure interaction. Is this free field, or is this basement -

MR. AKE: This does not include the effects of soil structure interaction.

MEMBER RAY: Exactly.

MEMBER CORRADINI: Okay.

MR. AKE: It's the input and all -

MR. STUTZKE: This is free field.

MR. AKE: Right, but would drive the use as the input.

MR. STUTZKE: Yes.

MEMBER CORRADINI: So the soil around the plant still is not taken into account.

MR. STUTZKE: If the plant weren't there.

MEMBER CORRADINI: Yes.

MR. STUTZKE: You said it the other way. This is a comparison of seismic hazard estimates. These are -- you see on the Y-axis, it's the exceedance frequency. It's the frequency of earthquakes that exceed a particular ground acceleration. And I have them from a variety of sources, the EPRI 1989 study, the revised Livermore study done in '94, a couple of USGS curves, including the one that was issued about two months ago, and the Early Site Permit. And you can see that both the ESP curves, and the USGS curves indicate higher frequencies when you get to the half G ranges.

MEMBER STETKAR: Marty, do you see that for a lot of sites? I'm just curious, because I've seen USGS consistently higher.

MR. STUTZKE: Yes.

MEMBER STETKAR: At the high G range.

MR. STUTZKE: It's generally true.

MEMBER STETKAR: Is there some understanding of why that is?

MR. AKE: I think the -- if I could jump in on that one, the biggest change that you see reflected in these curves that Donna changed is as Annie alluded to earlier, is the change in the ground motion prediction equations, and the newer ground motion prediction equations tend to predict slightly higher ground motion values, and they also tend to yield slightly flatter hazard, because, you see, the other thing that has changed in these curves is the slopes of the curves change, which is also something that affects where we'll end up with our estimates.

MEMBER BANERJEE: So if that's true, why is the ESP 2003, if it's an evolution of the model does that mean that the ESP 2003 is a very different model from the USGS 2003?

MR. AKE: The ESP model used a different set of -- a different attenuation function than was used by the USGS, slightly different. And I think there are a couple of other minor differences between the models.

MEMBER BANERJEE: But there's a significant difference in the peak ground acceleration around 1G.

MEMBER APOSTOLAKIS: But we never go there. Where are we usually, we're in .17. The SSC's where are they?

UNIDENTIFIED SPEAKER: They've been reading around .3.

UNIDENTIFIED SPEAKER: The SSCs are typically -- .3 would be on the high end of the SSCs.

MR. STUTZKE: The .3 is more typical of the high confidence, low probability -

(Simultaneous speech.)

MEMBER APOSTOLAKIS: So these curves are medium curves. What are they?

MR. STUTZKE: These are mean hazard curves.

MEMBER APOSTOLAKIS: Mean hazard, so if I go into about .2G, are there really significant -- where is it?

(Simultaneous speech.)

MEMBER APOSTOLAKIS: Somewhere there, and it's not that bad. The ESP, it's about the same as all -- I mean, all three of them .7 really.

MEMBER CORRADINI: If this is off base, Dan, you stop me, but I just got the -- I want you to kind of restate what you said about the model. So this is -- there's no plant involved, but I'm sitting on the ground where the plant might be, and I'm coupling the point source to that location, and the model of coupling is different between the yellow curve and the pink curve, and the light blue curve.

MEMBER APOSTOLAKIS: Coupling what?

MEMBER CORRADINI: Coupling the point source.

MEMBER BANERJEE: The power point source, necessarily, can be -

(Simultaneous speech.)

MEMBER CORRADINI: And I'm standing on the ground, and the way I model that propagation of the waves is different.

UNIDENTIFIED SPEAKER: There's more than one source. There's several sources that we're modeling here. We have several sources that we're modeling, we're compiling all those together to come up with this hazard curve. So the source models are different, the ground motion models are different between these different groups. There's similar parameters. Obviously, there's some agreement on magnitude and how often earthquakes occur in the ground motion models, but -

MEMBER APOSTOLAKIS: The combination, in other words.

UNIDENTIFIED SPEAKER: Yes.

MEMBER APOSTOLAKIS: But still, my question is what difference does it make? I mean, for the region -

MEMBER POWERS: George, why don't we let him go through it, and that's what he's trying to tell you.

MR. STUTZKE: And my quick and dirty answer is when you do the seismic risk estimate, you're integrating over the all acceleration range. You integrate over the entire ranges of acceleration, you're not just picking one point off of the curve, so the slope of the curve, it all makes a big difference. It's not at all obvious how it affects, it's highly non-linear.

So a background on the generic history, the concern was identified in May of 2005 by NRR. This was, of course, before NRO was created. It's the same body of people. They raised the issue, but still have concluded that they thought there was adequate protection to the plants. The Office of Research opened up the issue in June of '05. There was various activities went on culminating in February of this year with a screening panel that concluded it's a real generic issue, and we need to proceed to the safety and risk assessment phase of our process.

We had held a public meeting that was well attended in early February of this year to talk about our plans to resolve this. The last bullet is something I'll remind you. When I was briefing you last month on our RASP program, I mentioned that we have an MOU between NRC and EPRI, and we've added a task to share seismic research information.

The Generic Issues program is laid out in Management Directive 6.4. It's basically our marching orders of how to proceed in resolving it. When we did the safety and risk assessment piece, they gave us these guidelines, these criteria up here to decide. And you'll see that it's laid out very much like Regulatory Guide 1.174, where we have a baseline core damage frequency, and we look at the change of core damage frequency, and the notion is if you're in the shaded area, we can stop work on the Generic Issue. If you're outside, then we need to continue to do some more work like this.

Now, there's a number of problems associated with this, and challenges. Philosophically, what does the change in core damage frequency mean? Normally, when we talk about it, we're talking about modifying the power plant, we're trying to fix something. We want to measure the benefit of that sort of shift. Here what we have is a change in our perception of the seismic hazard. The hazard probably hasn't changed, we just are interpreting the data different ways, so delta-CDF, in my mind, is with respect to what? What do you we use as the baseline frequency here? So that's something we've been puzzling over for some time.

More specifically, the process, what it tells us to do is to pick a surrogate plant and go forward. And the idea is that the surrogate would in some sense be a bounding plant, so if you're trying to show that all the plants in the country fall within this shaded area.

MEMBER ABDEL-KHALIK: Why is this any different than uncertainty in the performance of a piece of hardware?

MR. STUTZKE: It's not really. It's a manifestation to some extent of modeling uncertainty with all the different assumptions, and things like this. The other thing is that it's difficult for us to let alone deal with the uncertainty, whenever we apply a screening criteria like you see here, the comparison is always done on mean values, so I'm not quite certain what the mean means in this case? That's the question I'm asking. But, anyway, let me go forward. We're still wrestling with it. It's not resolved, I think in my mind, to an acceptable level.

But the problem we have is, it's real hard to pick a surrogate plant. Site hazard is site-specific, the seismic is site-specific like this, even the fragility within the site can be different, so I can have different fragility levels, HCLPF values for Unit 1 than I have for Unit 2. So it's really difficult to claim that you could find a bounding plant. And, of course, we want to pick a process that we can defend like this. It's applicable, we can implement it easily, so forth and so on.

Under the IPEEE program, about one-third of the licensees did full seismic PRAs. The rest of them all did seismic margins PRAs. And there are substantial differences between them. Notably, the seismic margin to PRA tends to ignore all the random failures, human actions, these sorts of things. They're strictly looking at the hardware, and it builds up to a plant level HCLPF value like this. And as you can probably guess, you know from your experience, seismic PRAs are tremendously expensive. These are multi-million dollar projects to implement, so I'd be perfectly happy to go to my boss, Dr. Shearon, and say look, I've got to do 104 seismic PRAs, and each one is $2 million, pony up.

MEMBER STETKAR: What's your basis for that cost, because seismic PRAs, given a good Level 1 internal event model of a plant, have been done reasonably well for a couple of hundred thousand dollars, or less. So I'm not sure why you say it's $2 million to do a seismic PRA. What's the basis for that estimate, if cost is, in fact, the driving factor behind why you need to take kind of a generic approach?

MR. STUTZKE: Granted, the simple answer is I have to go through laboratories. I have expenses.

UNIDENTIFIED SPEAKER: Why?

MEMBER BANERJEE: To an MIT grad student.

MEMBER CORRADINI: No, but I guess I wanted to ask -- forget about the money, because we're not here to talk about money. I guess I wanted to understand the process. Is the difference between the two is the individuals involved in all the front end work in terms of effort elicitations, because of the site-specifics, or is it simply because of -

MR. STUTZKE: Okay. The expensive part of the seismic PRA are the plant walk-downs, getting hold of the experts.

MR. CHOKSHI: Excuse me. Let me clarify. This is Nilesh Chokshi. Cost aspect depends on the level of details that we have to go to. PRAs are iterative-type things, you figure out what the level of detail you have to go through. The fundamental difference between the PRA and margin is margin is, essentially, very simplified. It is the element sub-PRA. It does not count core damage frequency, it just estimates plant capacity. And it was derived from the PRA insights. And, in fact, it was an ACRS-driven question that is there a lift beyond the SSC. Is there margin from the design points, and that's what the seismic margin was designed to answer, rather than calculating core damage frequency.

MEMBER BLEY: Nilesh, to do the margins, don't you have to essentially do the fragility analysis to come up with the HCLPFs?

MR. CHOKSHI: Yes, what you do is there are two approaches. You can do the fragility or there is called conservative deterministic margin approach, but you have to do the calculations. The only thing is that because you are not doing full scope and point to all the other seismic condition initiators, like large LOCA, your scope is smaller, and you can use historical experience base to pin things. But, again, the PRA depends on how far you need to go to answer the question, so it's not that PRAs are always going to cost tremendous more, margin approach. Particularly, as mentioned, if you have a very detailed Level 1 PRA model, you have to modify it.

MEMBER BLEY: Okay. Thanks. I was just

curious where the $2 million came from.

MS. EWELL: Can I also add, as far as either using a bounding approach, the Generic Issue program is supposed to be just that, taking a look at an issue and determining whether or not it rises to the level of interest for the NRC to take action, as well as then perhaps engage the industry. And, of course, the fact that considerations come into play, so the concept of doing 104 plant-specific analyses is just not part of the GI approach, because what we're trying to do here is get an estimate, and enough technical basis to say yes, industry, you need to answer this question for us, because we are not coming up with the industry's answer for them. We're just determining whether or not we have a technical basis to ask the question. So I don't want everyone to walk away thinking that the Agency is cheap and is trying to cut corners.

MEMBER APOSTOLAKIS: If you convince them to do that, maybe to do two or three Level 2 PRAs.

(Laughter.)

MR. STUTZKE: The other thing I'd point out is there's a matter of resources. There aren't that many seismic PRA people around any more. I mean, two of them are sitting right here. Okay. And the ones that are available all seem to be off doing new plant stuff, so it's a complicated problem.

So we came up with this process that says it's basically following some work done by Dr. Kennedy. It's referenced in Appendix D of the ANS Standard on External Event PRA. And the process works like this; it's that you fit the hazard curves to a power log, so they are linear in log-log space. Then you develop a plant level fragility curve, so it's like a super component for the entire plant like this, and it's log normal. And you can do that if a seismic PRA was actually done for the IPEEE, you already have the curve. You can pick the points. If seismic margins was done, you use the reported high confidence low probability of failure that's equal to a 1 percent probability of failure. You assume a composite log standard deviation of .4, could be at .3, so .4 is the recommended number. And the point is with that, seismic CDF now has an analytic form, I'll show you. It's simple. There's an equation for it. I mean, it's easy to implement.

MEMBER BLEY: Do we know, or have a good feeling what that invented fragility curve kind of means with respect to the plant? Where the .4 comes from.

MR. STUTZKE: Well, I can defend it like this. First of all, I don't need to know the risk contributors that you would get out of a PRA. I don't need to know it's this component or this structure. What I'm trying to do is come up with a simple way to compare the differences in the hazards, and suppress the plant response sort of thing like that.

The other thing is that we've done a lot of testing in the last couple of months where instead of fitting up to a power log, we fit it to other curves. We do a point-to-point convolution, so I've looked at the numerical details like that. This method reproduces the known seismic PRA results in a large number of plants.

MEMBER BLEY: That's helpful.

MR. STUTZKE: Yes.

MEMBER APOSTOLAKIS: I don't understand something that says if an SPRA was done, pick the plant level fragility to log-normal distribution. Where does that -- I mean the seismic PRA normally does not produce this super fragility.

(Simultaneous speech.)

MEMBER APOSTOLAKIS: I'm sure that is the case, but how do you that?

MR. STUTZKE: What I was able to find in

every IPEEE submittal or in a response to a staff request for information, this curve -

MEMBER APOSTOLAKIS: Exists?

MR. STUTZKE: Acceleration, probability of failure.

MR. CHOKSHI: You can control from the different sequences a plant level fragility -

MEMBER APOSTOLAKIS: I suspect that's how it's done. My question is, is it actually done? Why should an SPRA do that?

MEMBER BLEY: I don't think they do.

MR. STUTZKE: Every single one.

MR. CHOKSHI: Then you can see any -- if you walk through the hazard sensitivity -

(Simultaneous speech.)

MR. CHOKSHI: And it's a much simpler way to do it.

MEMBER STETKAR: They back it out of the results. They don't produce it for the quantification. They do the quantification, and then infer an effective plant level fragility curve.

MR. CHOKSHI: It helps for the sensitivity then, changing the hazard -- and, in fact, that's here what Marty is doing, is changing the hazard. That's why this approach. See, the plant fragility stays constantly. He's looking at changing the hazard.

MR. STUTZKE: Okay. This is my, I guess, viewgraph that's in color and it has equations on it. It's just to let you know why I'm a Senior Technical person.

(Laughter.)

UNIDENTIFIED SPEAKER: It's got log scales and log linears. I mean, this is great.

MR. STUTZKE: Okay. So the hazard curve looks roughly like on the left-hand side here. It's the exceedance frequency. This is the power log fit, case of IA to the minus case of H. You'll hear the seismic people will talk about the slope of the hazard curve, they're talking about case of H like this. And you can see the linear fit. It's not unreasonable. Of course, a real hazard curve dives off at high accelerations. You can get infinite accelerations. Similarly, with the power log, what it actually predicts mathematically is the frequency of very small earthquakes approaches infinity. That doesn't make a lot of sense either, but it's certainly bounding.

This is the equation for an example, fragility curve, the mean value, which is what we're convolving the mean hazard against the mean fragility.

CHAIRMAN SHACK: In very small earthquakes it's pretty high, so it doesn't make much difference.

MEMBER STETKAR: Yes. The good news is it exists in plants, the change in the relation to the hazard -

(Simultaneous speech.)

MEMBER STETKAR: -- doesn't make much difference.

MEMBER APOSTOLAKIS: Now you tell us that this is a research issue?

MR. STUTZKE: It is.

MEMBER APOSTOLAKIS: Is your approach sensitive to that?

MR. STUTZKE: Well, right now because we're using the hazard curve - remember, the motivation for the power log fit is to be able to get an analytic form to the integral here. That's what makes it easy. Normally, when people do seismic PRAs, in fact, in NUREG-1407, we told them to truncate at 1.5G.

MEMBER APOSTOLAKIS: So you're picking one.

MR. STUTZKE: Yes. We're just picking one.

MEMBER APOSTOLAKIS: All right.

MR. STUTZKE: And it actually turns out

with this power log you don't have to go to infinity. You can integrate over any two fixed acceleration ranges like that, as well.

Of course, what we're doing is convolving the mean hazard against the mean fragility. That's not the mean seismic core damage frequency, but it should be -- okay. So to finish up briefly, as I say, we've been doing a lot of work on developing methods and convincing ourselves of different technical approaches, numerical integration schemes, things like this. I've been compiling the data by reading the IPEEEs, things like this.

We'll hold another public meeting once we get done with the safety risk assessment. Our panel will reconvene, and, of course, there'll be a report to the panel. The purpose of the panel then is to decide whether they want to go forward with the regulatory analysis assessment phase of this. Now, the difference is the regulatory assessment phase is going to decide what is the regulatory action, what's the response? They're going to write a Generic Letter, they're going to write a write a risk, they begin to rule make, are we in compliance space? What are we actually going to do?

MEMBER APOSTOLAKIS: So this approach at

the high level is going to help you calculate the delta-CDF of the managing directive.

MR. STUTZKE: That's right.

MEMBER APOSTOLAKIS: There are so many approximations here, and then you will look for a delta-CDF of 10 to the minus 5.

MR. AKE: The idea is if we make the same consistent set of assumptions using two different sets of hazard estimates, we will have a reasonable idea of what that change is.

MEMBER APOSTOLAKIS: Yes, but I mean you say that -

(Coughing.)

MEMBER APOSTOLAKIS: What happens if it's .5?

UNIDENTIFIED SPEAKER: As long as they're consistent on the fragility side, that's not what we're looking at.

UNIDENTIFIED SPEAKER: We're looking at the difference in hazard curves post ESB. I mean, where we are now, and where we were in the -- when we did the IPEEEs. That's what we're looking at, so we're looking at the change in the hazard. As long as we consistently model the fragility in the same way, then we're okay.

MR. CHOKSHI: No, the question is if you use to instruct .4, .3, .5 what happens? And I think that will be the kind of things you look -

UNIDENTIFIED SPEAKER: Yes, we will certainly investigate.

MEMBER APOSTOLAKIS: It's not just that. I mean, the whole idea of having this super fragility curve of the plant, and then doing these things, there is a lot of uncertainty and approximation. And then you're saying, and now based on those, I don't want to use the word "gross", but significant modeling approximations, now you want to take the difference of two very uncertain quantities, and decide the basis of whether it's 10 to the minus 5, or 10 to the minus 6. Something is wrong with that.

(Simultaneous speech.)

MEMBER POWERS: One of the things that's wrong with 1.174.

MEMBER APOSTOLAKIS: I didn't hear that, but you are -

MEMBER POWERS: Wrong with 1.174 -- we always take delta in highly uncertain terms.

MEMBER APOSTOLAKIS: I'm not doing this magical.

MEMBER POWERS: A different form of magic.

MEMBER APOSTOLAKIS: Which is not black. Look, I don't want to attack the approach, because I appreciate that the problem Marty and his colleagues have is very, very high. But maybe if we acknowledge this, we can be clever and so some sensitivities, or something to address it. I mean, it's not like I have a better approach.

MEMBER BLEY: It's just I think the thing that's sitting not quite right with me, and I like the idea of sensitivity studies, is for the plants that had a seismic PRA, and they had a -- they have the overall plant fragility curve, you are able to do some tests. But for plants that had the seismic margin, you didn't have a seismic core damage frequency, so does that simplified approach work very well? I think there's no way to really know that without a test or something.

MR. CHOKSHI: I think that's the point for assumptions, is basically any two parameters for log normal distribution, and you can get the HCLPF value out of that analysis. Point four, there's a lot of study has been done. This is not only used here. This has been -- the .4 has been -

CHAIRMAN SHACK: Performance-based SSC is the same analysis.

MR. CHOKSHI: And a lot of study has been done on the sensitivity of core damage frequency to the different assumptions. And .4, it's based on a usual component, we know what kind of uncertainties are, which are integrated through the -

(Coughing.)

MR. CHOKSHI: So there's a fairly robust basis for why we are using .4. And you have to go, and it can give you the data, but I think sensitivity study, we always do that, because this is an assumption.

MEMBER BLEY: I think that would help. And I'm not familiar with the pedigree of where that comes from, so I don't know -- I don't have that knowledge.

MR. CHOKSHI: This is -

(Simultaneous speech.)

MR. CHOKSHI: And it's performance-based. There was a lot of things done to examine this particular question.

MEMBER BLEY: Fair enough.

MR. STUTZKE: The other thing I would point is that for most of the plants that did seismic margins, all you know is that the HCLPF is above the review level. You don't know the true HCLPF figure.

UNIDENTIFIED SPEAKER: That's right.

MEMBER BLEY: So it is probably a lower bound than -

MR. STUTZKE: When seismic margins was done, what you do is postulate the review level earthquake, and that was specified -

MEMBER BLEY: Postulate a?

MR. STUTZKE: Review level earthquake. Said convince me that the seismic capacity is at least th is much. And for most plants, it was .03Gs. And what you get out of the results of that is they came back and said yes, we confirmed that it's at least .3Gs. The point is you don't know how high it really is. You don't have -- you don't really know the true capacity. You know it has to be above .3Gs, so a fragility curve that is based on this .04 beta sub C, and the review level earthquake should be conservative, but I don't know how conservative.

MEMBER STETKAR: Marty, I hate to put you on the spot, but to tie together the two -

(Off the record comments.)

MEMBER STETKAR: You glossed, or at least maybe I wasn't listening closely enough. You said that your baseline CDF, I was going to ask you about what I think is the difficult part of the problem. The baseline CDF, this is in Slide 8, you're going to use the 1999 EPRI seismic hazard curves, and you said you're going to use updated seismic hazard curves for the -- to evaluate the change. Any idea what updated seismic hazard curves you're going to use? I mean, are you going to just select USGS because they look consistent and are higher? Given the fact that the research folks are heavily involved on trying to estimate what those hazard curves really are.

MS. EWELL: Can I just interrupt at one point here, and that is, I think we're -- what we're trying to do with the generic issue process is to determine whether or not we should engage the industry. The final regulatory decision on what action, and the final, what has to happen at each plant is going to be a function of the actual analyses provided by the plant, if it gets to that point. So I think what we're doing here is trying to do something that's bounding, that's conservative, but yet is not so completely wrong that it doesn't stand up to some technical scrutiny, but it makes us say oh, geez, we have enough information to then ask the more specific questions to each of the plants, or what subset of those plants, if we can narrow it down. So the accuracy question, the final regulatory decision is not going to be solely based on what we're doing here. That's all I was trying to put in perspective.

MEMBER APOSTOLAKIS: If you make the convincing case that what you are doing is conservative enough, I have no problem doing what you said.

MS. EWELL: Okay.

MEMBER APOSTOLAKIS: Now, given all this, if I go back to Slide 4, why can't I say that the differences are small if I integrate a few things, I will find small differences -- the curves are not that different.

UNIDENTIFIED SPEAKER: This is one site. This is North Anna in Virginia.

MEMBER APOSTOLAKIS: Is there another site where you really have big -

UNIDENTIFIED SPEAKER: Well, what we're looking at is okay, now we under the New Madrid is the type of an earthquake in New Madrid is not going to be once every 2,000 years, or 3,000, I can't remember. But now we're saying it's every 500, or 600 years. We're saying a Charleston earthquake in South Carolina is now maybe between 500-750 years, as opposed to what it was thought before, several thousand years, or at least two or three thousand years. So that's the kind of difference in hazard, plus the new ground motion prediction equations, that we're trying to look at for the new plants, operating plants, and say what is the implications of those new findings that we have.

CHAIRMAN SHACK: George, then we want to at least include a first order approximation of the plant response to this change. I mean, it's -

MEMBER APOSTOLAKIS: I didn't say I didn't want to.

CHAIRMAN SHACK: Well, I mean, it seems to me it's almost -- if you argue that you can work from this and make the approximation, I'd say oh, maybe, but I'd sure feel a whole lot better if they at least included a first order estimate of the response of the plant.

MEMBER APOSTOLAKIS: Let me understand you. The comment about New Madrid and so on, these visions are not reflected in these curves?

MR. STUTZKE: No.

MEMBER APOSTOLAKIS: They're not, not the difference?

(Simultaneous speech.)

UNIDENTIFIED SPEAKER: I mean, the differences -- what you're seeing is North Anna is far enough away from what I was just talking about, Charleston, and New Madrid, that the differences aren't really showing up here. Is that going to be the same story for all the operating plants? That's what we're looking at.

MR. CHOKSHI: George, can I -

MEMBER APOSTOLAKIS: Please understand. I'm not -

MEMBER POWERS: I think we've heard enough, to be honest with you. I think it's time to move on to the next topic.

MEMBER APOSTOLAKIS: There is the next topic.

MEMBER POWERS: We've got two more to go, George.

MEMBER BANERJEE: One is on the Japan earthquake.

MEMBER POWERS: My intention, by the way, is after this discussion of high frequency ground motion, is to take a break, and then come back and do the Japan. I didn't hear you, George.

UNIDENTIFIED SPEAKER: Nothing, nothing. Let it go.

MEMBER APOSTOLAKIS: You're behind. You're not running it very well.

(Off the record comments.)

CHAIRMAN SHACK: If we can come back into session here.

MR. CHAKRAVORTY: Well, I'm Manas Chakravorty of NRO, Structure Engineering Branch. The background, I have been to NRC not very long, probably nine months or so. Before that, I was -- I started my career at a nuclear plant and Stone & Webster Engineering Corporation, and before that I had some graduate studies at MIT.

(Off the record comments.)

MR. CHAKRAVORTY: When I did my research, these probabilistic methods and things like that were really a surprise to the industry. But, at any rate, I have been in the nuclear industry for more than 30 years, and I was at South Texas project Nuclear Safety Review Board. And then doing some out of retirement, I got bored, and then I thought it's time to do some regulatory activities. My friend was here, so I started here.

Let me give you some background. I think you are already aware of most of the background for this interim safety guide. Basically, there has been significant advances in seismological knowledge, which led to updated ground motion prediction for the Central and Eastern United States. And although we didn't build very many nuclear plants, but our quest for knowledge continued, and we learned a lot. And, as a result, we had some predictions about data ground motion models for earthquakes in the Central and Eastern United States, some recent application in our ESP reviews. We have identified that site-specific ground motion may not be enveloped by certified design response spectra for some sites. Industry requires some guidance on the evaluation of metrics for assessing effects of these exceedances, where ground motion response spectra exceeds the site-specific design response spectra. And, basically, we call those high frequency issues. However, it could be low frequency issue, also, as you might be seeing at Kashiwazaki plant that some of the spectra exceeded at low frequencies. So it applies anywhere, but we are concerned here mainly on the high frequency side.

This gives you an idea -

mEMBER BANERJEE: Is there low frequency things associated with fault type earthquakes?

MR. CHAKRAVORTY: It could be local side geology fault. I'm not a geological expert, but it could be many things, but it did happen over there.

MEMBER APOSTOLAKIS: Well, certainly in Japan, yes.

MR. CHAKRAVORTY: This gives an idea of what a certified seismic line spectra looks like. This is primarily based on Reg Guide 160 spectra. If you see the lower dotted line, which is the minimum PGA, .1G that we're required to meet. In other words, any design center really can ask for application certification for this spectra down below, which is at the dotted line. That's what our regulation requires, that you have to have a minimum of .1G.

MEMBER CORRADINI: Can you say that again? I'm sorry. Can you repeat that? I didn't understand the difference.

MR. CHAKRAVORTY: What I'm saying is these are generally the spectra, the top one, the red line, is the one that the design centers supply as they are certified, which is normalized for .3G ground acceleration. Okay?

MEMBER CORRADINI: All right.

MR. CHAKRAVORTY: Our regulation, minimum requirement as per Appendix S, is .1, that's the minimum.

MEMBER CORRADINI: But it doesn't matter what the regulation says, you're using the red.

MR. CHAKRAVORTY: Yes, exactly. But people can ask for application, there's a marketing point, how much you go. If you go to the other curve, this is a green one which is kind of Central and Eastern United States kind of soil site, which is generally enveloped by our so-called certified design spectra. If you see this, the blue one, which one is the hard representative Central United States, hard rock site spectrum, which you have seen it before also in many other presentations here.

The problem area is this, where it exceeded 10 hertz or more, we see that there has been some exceedance of our certified design spectrum.

MEMBER ARMIJO: I've got to ask. Why did this happen? I mean, what discovery that led all of a sudden to the exceedance? Was it new data, new -- how did -

MR. CHOKSHI: I think to answer your question, let me -- you need to go back to the building, how we first started designing the nuclear power plant. Those red curves initially were based on 30-40 years back, when we only had Western U.S. records, and because those are not - answering your question about magnitude, those are primarily a magnitude of 6-1/2, and maybe plus/minus, so the high magnitude earthquake and the ground conditions there produce this kind of spectra. And those were our design basis. But as we learned more about Central Eastern U.S. and how the ground motion attenuated or propagates, we get -- and most even small magnitude, 5, 5-1/2, which have a lot of high frequency, but I don't have this low frequency component of the spectra. And that's -- as learn about Central Eastern U.S., and it's been -- this issue has been known for a while now, because it's been -- we have seen, as we learned and started to predict Eastern ground motion models, so that's the reason. But I also want to make one point.

The low frequency component from the engineering point of view is the critical, these structures, components are generally in that. And we are -- I mean, that you need to remember towards the discussion. I mean, that's what drives the engineering design.

MEMBER CORRADINI: So can I just ask one last clarification about this. So if that's the case, then the only thing that would be affected would be small mass components within the large mass plant. So does the large mass plant dampen the small mass components' response to this spectra? In other words, I've got a big, hawking big plant that only moves once I see -

MR. CHOKSHI: In fact, it is going to go up -- we take into account those effects.

MEMBER CORRADINI: Okay.

MEMBER BANERJEE: I have a question. If it's very low frequency, then it doesn't excite any resonances, so it's really the intermediate frequencies which start the spectra -

MR. CHOKSHI: That's a good question. I mean, most of our things I would say within, say, 2 and 10 hertz.

MEMBER BANERJEE: Right.

MR. CHOKSHI: But there are things like tanks, or where you have to -- which could be low frequency components.

MEMBER BANERJEE: Very low.

MR. CHOKSHI: Low low.

MEMBER BANERJEE: Below one.

MR. CHOKSHI: Right. And the things like sloshing water levels, those are affected by the low frequency motions.

MEMBER APOSTOLAKIS: So the range of frequencies of interest is between 2 and 10, you said?

MR. CHOKSHI: Basically. It doesn't mean -- that's for structure.

MEMBER BLEY: Structure is not equipment.

MR. CHOKSHI: Well, one of the two plant is also. I mean, things which has a -- what you are concerned about, structural integrity type things, or where the structural -- this design will go on tends to be more of those -- the things like very small mass, very rigid things which you have a high -

MEMBER CORRADINI: Well, the reason I asked the question is that -

(Simultaneous speech.)

MEMBER CORRADINI: You have to transmit it. The only reason I'd worry, I thought the only reason I'd worry about the blue line is I have to transmit to some small inertia, small mass, small inertia component, but I'd have to transmit it through something else.

MR. CHOKSHI: Through structures, and the ground.

MEMBER CORRADINI: Thank you.

MR. CHOKSHI: And he's going to talk about that.

MR. CHAKRAVORTY: So in the Central and Eastern United States, as we see some rock sites, the site-specific ground response spectra are higher than the certified seismic design spectra at high frequency range.

Again, you'll note that the ESBWR, their certified design spectra would really look like this up to red, and then portion of the blue. So that is the ESBWR, like a double hump CSDRS. But not all the plants had that certified, like AP1000 has this red one, kind of. It's not exact, but -

CHAIRMAN SHACK: ABWR has the red one.

MR. CHAKRAVORTY: Right. So that's why we have to really look at how these things work. So what did we do? We had quite a few meetings, a number of meetings with industry, and also we undertook development of some methods, how to realistically address these situations. And industry met, and NRC met, and then we came -- basically, all the results of those discussions included that in our updated safety standard review plan. This regards the work for review of high frequency exceedances, the SRP allows that use advanced analytical techniques such as use of incoherency of earthquake motions with the special variations inside that, so that helped. And so, SRP provides those guidance.

MEMBER RAY: Is the vertical component always a fraction of the horizontal?

MR. CHAKRAVORTY: Yes, but generally these applications, they are using the same, almost the same number.

MEMBER RAY: Two-thirds?

MR. CHAKRAVORTY: They are not using two-thirds. The one that I know, like APR application, they're using the same 4 and 3g for both vertical, as well as horizontal.

MEMBER RAY: So they're using the same.

MR. CHAKRAVORTY: Same.

MEMBER APOSTOLAKIS: Is it two-thirds, or one-third?

MR. CHAKRAVORTY: Two-third, we used it before. When I used to the design the plant, I used to design for two-thirds, long back.

UNIDENTIFIED SPEAKER: Yes, you're right. The OBEs -

UNIDENTIFIED SPEAKER: I'm talking about the vertical -- a function of the horizontal.

MR. CHAKRAVORTY: So SRP provided us some guidance. For example, if it exceeds the GMRS and the GSDRS level, then we go to the next step. WE calculate the closed spectrum foundation spectrum, including all structure and soil structure interaction, and do this coherency. Now you calculated the spectrum again at the foundation level, and then compare those. Maybe a lot of the experience is that you have seen in the ground motion response level may not be there because of filtering out by the structures, and other things there. So those are the graduated steps that we have provided in the SRP.

Now, implementing the SRP framework, the staff developed this interim staff guidance on seismic issues. The ISG identifies information to be included in an application to address this issue. It also presents staff technical positions, as well as acceptance criteria for high frequency analysis, and evaluation metrics for structures, systems, and components. So that's the reason we give the issues -- we issued the ISG.

Now, what ISG has, ISG provided definitions of various ground motion. Basically, people were confused, what is the SRGAs, what is GMRS, what is FIRS? So they provided a systematic structure for those definition of various ground spectra that we use, or terminology. And you will see that in Section 2 of the ISG.

It also provided guidance on the use of different ground motions, guidance on the use of OBE level in pre-earthquake planning, or also maybe post earthquake planning on Regulatory Guide 1.166, which is really when you've have to trip the reactor. And they provided some guidance, so now it is, they allow, or regulation allow use of one-third of the SSE as an OBE value. Before it was half, now they use a lower number. So there is some guidance on there on seismic instrumentation that we are planning, Section 3.

It also provides staff expectations on the content of COL application, when limited soil testing data is available. In other words, there was some difficulty getting soil testing labs previously, and the industry developed a White Paper that they wanted how to use a limited number of tests, and the staff approved those, and provided some guidance as a minimum what they are expecting. So that's also included, and that's included in Section 5 of ISG.

Also included in the ISG, that's the main portion of ISG, is the guidance on evaluation of high frequency exceedance. In other words, when that exceeds beyond 10 hertz, what we do, so ISG provided it allows inclusion of incoherency in structural response analysis, identified acceptable SSI analysis codes to include the effect of incoherency of earthquake motion. It also allows screening of high frequency sensitive systems and components, and the evaluation of screening age, and how do you screen, and when you screened in some components, then how do you evaluate those? And what information we need, and these may be some evaluations which are in addition to the CSGRS-based seismic qualification program that the applicant had used previously. So those are some of the guidance that is in the ISG.

Basically, let me summarize what we have. We had a problem, and we fixed -- and we tried to resolve the problem. We provided some framework in SRP 3.7, and ISG to address this issue. Currently, AP1000 topical report, they have submitted this to us, and we are currently reviewing that, so we'll gain some experience how well it is working.

ESBWR has used CSGRS, that envelope both soil and rock sites, so we really don't have any problem. That will be their CSGRS. Okay? That's what they have decided. As we gain experience to actual implementation by a few applicants, the ISG will be incorporated in the standard review plan, or regulatory guide as appropriate, but we want to look at the experience, how it works, where there might be little bit areas for improvement, and things like that. So far, it's going pretty good, and that's basically what my presentation is.

MEMBER ARMIJO: What is the ABWR doing?

MR. CHAKRAVORTY: ABWR, they have the old spectra. Okay? And right now, the only application -- which application, they have STT, which is a soil site. Okay? So they will be covered on that one. However, if a hard rock site, of course, we have to go back and do the same kind of thing, because it is really design center specific. You cannot address it for AP1000, and then you extend, extrapolate it to ESBWR, because systems are really different, equipments may be different, so we really have to go on a design center basis. All the CSDRS are design center specific. It's not the standard thing. I can design for the .1g and sell -- that's my CSDRS. Okay? If I want to build this plant in Japan, of course, you have to address the other GMRS. And it can be done.

MEMBER ARMIJO: Build anything in South Texas.

MR. CHOKSHI: Let me just add one more thing, because I think the industry -- this approach, incoherency approach was developed over several years, and industry did a lot of studies. So I don't want you to understand that industry opposed this approach, and conducted evaluation of recorded earthquakes, and we engaged quite a bit, so this has been a product of multi-year of work.

MEMBER POWERS: Okay. We'll take a break

until 10 of, and then we'll come back.

MR. CHAKRAVORTY: I'd like to thank you.

MEMBER POWERS: Thank you.

(Whereupon, the proceedings went off the record at 10:36:05 a.m., and went back on the record at 10:51:06 a.m.)

MEMBER POWERS: We think that the earthquakes in the Western United States and the earthquakes in the Eastern United States and we're going to look a third class, one of a subduction zone earthquake which ought to be different from everything on the face of the earth and Mr. Li will discuss with us the Japanese earthquake and its impact on the Kashiwazaki -- Is that a correct --

MR. LI: Kashiwazaki, yes. That's -- name. The earthquake is actually called Niigataken and Chuetsu-oki earthquake.

Anyway, thanks for the opportunity and I'll brief you on this earthquake and its impact to the power plant.

MEMBER POWERS: This is a bit of advertising. The American Nuclear Society does plan to have a session at its regional meeting on this particular earthquake with speakers and whatnot. So we all go visit Sam and learn about it at a meeting.

MEMBER ARMIJO: That's right. You're all welcome.

(Laughter.)

MR. LI: By July 15, it's the anniversary of the earthquake at 9:00 p.m. The earthquake occurred at 9:00 p.m. on that day.

MEMBER POWERS: Yes, but that would be 9:00 p.m. -- that would be July 14^{th} for us, wouldn't it?

MR. LI: No.

(Simultaneous conversation.)

It's actually July 16, yes.

MEMBER SIEBER: Too bad the earth is round.

MR. LI: Right. And the anniversary, but we spent a lot of time talking about the earthquake last year and I vaguely remember I was actually preparing three documents, talking points, summary documents and the Q&A in a very limited time frame.

(Laughter.)

Meanwhile, I had to answer questions from somebody who sent the questions through their BlackBerry. Yes.

Anyway, I'm going to start with the earthquake, the basic parameter, and then we're going to talk a little bit about the basic information about the Kashiwazaki-Kariwa nuclear power plant. Then I'm going to talk about the impact of earthquake vibration to the power plant facilities and, lastly, I'm going to talk about the major findings from the earthquake impact to the power plant. And --

MEMBER POWERS: Equally of interest to this particular Committee would be the damage to the infrastructure and the ability to respond to the plant from outside. So any comments you have on that would be welcomed.

MR. LI: Would you repeat? Damage to the power plant?

MEMBER POWERS: No, damage to the infrastructure surrounding, the highways --

MEMBER CORRADINI: Bridges.

MEMBER POWERS: -- the bridges.

MR. LI: Highways and the bridges surrounding, okay.

Yes, you can do any question on those issues you are interested in, but when I was preparing these slides, we were very careful because some of the information is proprietary from TEPCO. But, fortunately, I just got notice from Andy Murphy at Research. There's a deal between TEPCO and IAEA reached probably last night.

(Laughter.)

And the information can be made public.

MEMBER APOSTOLAKIS: Our night or their night?

(Laughter.)

CHAIRMAN SHACK: I'd say it doesn't make any difference because the time zones are all --

MEMBER POWERS: In consideration of subsequent presentations, I think we ought to let this presentation just go through and speak questions of clarification and not --

MR. LI: Yes, let me explain a little bit about the earthquake, the name. The Niigataken earthquake Chuetsu-oki means the Niigataken County like Baltimore County but there's --

MEMBER POWERS: Right.

MR. LI: Oki means "open sea." So the earthquake occurred actually offshore about 16 kilometers from power plant.

MEMBER SIEBER: Pretty close.

MR. LI: And the magnitude of the earthquake is 6.8. It was actually 6.6 a year ago, but those kind of information has always been updated because more arrival time, more simulation. You can refine your estimate about the magnitude of the earthquake and you -- Don't overlook that small difference because one magnitude difference actually means a difference about 30 times and the earthquake occurred at the depth spot of seven kilometer at the surface and the accentual difference from the earthquake to the power plant is about 16 kilometers. The hypocenter difference is about 23 kilometers. I'll explain that later. And no direct fault displacement at the power plant, even the fault projected beneath the power plant. But the vibration impact is abundant at the site.

Talking about the earthquake in Japan, let me give you some statistics at the beginning, also about the Niigataken. They are so famous in the seismology circle there.

First, I'll give you some status about the earthquake in Japan. There is a status about the earthquake occurring between 1994 and 1995, five years. Twenty percent of the measured six earthquake occurred in Japan and the surrounding area, but 80 percent occurred throughout the rest of the world.

(Laughter.)

Think about the area of Japan. It's about the size of California. Okay.

MEMBER SIEBER: Right.

MR. LI: So that gives you some pretty idea about the seismic activity in Japan itself and talking about the Niigataken, the county itself, also you probably came across some pictures which shows lows the ratings about four to five score, tilted but not configured class. That's from Niigataken. That event occurred about in the 1960s and it's so famous for the fashion started in that whole world. It's actually the typical example there. And the earthquake caused 15 casualties, 2,315 injuries, and collapsed the houses and cracked the highways in the affected area.

Okay. Look at the information about the nuclear power plant at Kashiwazaki-Kriwa nuclear power plant. It's the world's largest nuclear power plant in terms of power output capacity. There are seven units at the site producing 8,210 megawatts. If you compare that with the biggest nuclear power plant in the U.S. that's in Arizona, it's only about 3,880 megawatts. And Units 1 through 5 --

MEMBER BROWN: That's electrical capacity?

MR. LI: Yes.

MEMBER BROWN: Okay.

MR. LI: And Units 1 through 5 are BWRs

and Units 6 and 7 are ABWRs. Actually one of the COL is acting as previously presentation mentioned, the submit is about -- It's going to be installed ABWR here in the U.S. It's in South Texas.

So Units 3, 4, and 7 was important operation at the time of the seismic event and Unit 2 was starting up. So four units were in operation at the time. The rest are in refuel outage, the rest of the units.

MEMBER BLEY: All seven of those are offline for a very long time. Right?

MEMBER ARMIJO: Since the earthquake they haven't been operating.

MEMBER BLEY: And for another --

MR. LI: So far still are sitting there, yes.

And let's take a look at the site. It's a picture taken from the air and from the south. You can see --

(Off the record comment.)

-- (Indicating) yes, Units 1, 2, 3, 4 and 7, 6, 5. Actually, this area is called Kashiwazaki. The other three units called Kriwa. That's why we have KK. That's it.

MEMBER BLEY: What's in between? I'm just curious.

MR. LI: Between?

MEMBER BLEY: Yes.

MR. LI: It's area and nothing there.

MEMBER BLEY: Open fields?

MR. LI: Open fields, yes.

(Off the record discussion.)

That's a sketch showing you the right location of the earthquake relative to the nuclear power plant. This is a map here. There's A to A^1. That's a profile which is on the upper left. You can see the 16 kilometers from the epicenter to the power plant and the 17 kilometer of the earthquake to the surface. The distance between the power plant and the hypocenter distance from power plant is about 23 kilometers.

This seismic event caused a huge impact on the KK plant and fortunately all the operating units are experiencing seismic scrams safety, successfully. I mean, Units 2, 3, 4 and 7 basically. However the ground motion observed at all seven units significantly exceeded the design values. But no damage to so-called As and A type of equipment. That's a Japanese standard of the seismic significance and the significant damage to the B and C type of equipment. I'll show you the classification next slide.

That's the classification based on Japanese regulatory guide Option 2006. Yes, the As and A type is listed on top here, reactor pressure vessel and those kinds of things and the B type include the turbine facilities and C type is transformers.

MEMBER APOSTOLAKIS: Are these what we call safety related?

MR. LI: Yes, A and As. Later on, actually called combination of As and A are S type. So assume that S stands for safety.

So that's the comparison between the observed value of the ground motion at the lowest foundation level of each unit, also side-by-side listed the design value. You can see the huge difference there. I pick up a dramatic one which is Unit 2 which is also an operating unit at the time when the earthquake occurred. You see the east-west direction component. The design value is 167 gal but the observed value is 607. It's about close to four times a difference there. Yes, again those units safely shut down during the earthquake. So all those highlighted units are operating units. The rest are the refueling outage.

MEMBER SIEBER: Did you get any breach or distortion of supports or anything like that?

MR. LI: Distortion?

MEMBER SIEBER: Of supports?

MR. LI: Yes.

MEMBER SIEBER: In the A type and As type systems?

MR. LI: There's a variation of the fuel rod jump out of support.

MEMBER SIEBER: Okay.

MR. LI: Yes.

CHAIRMAN SHACK: Now when we say "design," is that an SSE value? What do they mean by "design" in the earthquake?

MR. LI: It's according to the SSE, but it's different from the SSE. This is on the structure. It's on the structure. How SSE is defined on the free surface and the free fuel. This is at the structure. So it's a one-to-one comparison here.

MR. CHOXI (phonetic): Yes, he's computing where the record was taken at that point in the plant. So it's something -- SSE would be different. We can compare. Okay.

CHAIRMAN SHACK: But when he says "design" earthquake, he means an SSE design, not an O

MR. CHOXI: Right. This is the value of the 167 that's coming out for the design analysis. Okay. And then 606 is the measure.

MEMBER CORRADINI: Just one last thing. So this is at location. So it's a fair consistent comparison. Whatever it is they design for X and solve

MR. CHOXI: So you see how more --

MEMBER BLEY: It's the same in our tutorial where this would be like measured at the basement.

MR. CHOXI: Well, this one, I think -- Yong, where is this measured?

PARTICIPANT: It's the basement.

MR. LI: The lowest level of the foundation. Yes.

MEMBER BLEY: It's the same thing.

MR. LI: Design value versus the seismic instrument recording there.

MEMBER SIEBER: In the aux or safeguards building.

MEMBER-AT-LARGE ABDEL-KHALIK: Have the design standards changed for these plants going from Unit 1 to Unit 7? I would have expected these ratios to be roughly the s

MR. CHOXI: I think as you will see that there are number of factors. One thing is the plants are different. Okay. They are not all the same, so different footprint and stuff and different rates. Also the local site conditions affect the responses and that's what is the point he's going to show later on why there are differences in the ground motion.

MR. LI: Actually, the ratio between the -- There's a huge difference between the Units 5, 6, 7 in combination versus the others, 1, 2, 3, 4.

MEMBER CORRADINI: But to Said's question and break it apart into pieces, the older plants are one through four.

MR. LI: One, two, three, four, right.

MEMBER CORRADINI: Right. The new plants are five through seven. So wouldn't I at least expect the design values to be higher and that kind of goes --

MEMBER POWERS: They are.

MEMBER CORRADINI: Okay.

MEMBER BLEY: Except for -- you mean?

MEMBER CORRADINI: Well --

MEMBER BLEY: The design --

MEMBER APOSTOLAKIS: The one on the left -

-

MEMBER CORRADINI: Yes, the one on the left is the design in all cases. So I'm just -- I mean the one thing that went through my mind is the one on the left of the slash is the design. So five, six and seven are bigger than two, three, four. What's going on with one?

MEMBER BLEY: One is the higher design.

MEMBER CORRADINI: Why is one's original design number higher?

MEMBER POWERS: I think you're pursuing an issue that maybe is an ancillary.

MEMBER CORRADINI: I'm sorry.

MEMBER POWERS: Please continue with your presentations.

MR. LI: Anyway, we have -- Since the earthquake occurred, we have accumulated so much data and documents. If you want some detailed explanation, we can give that to you with using an opportunity like a brown bag lunch. So we can do this in an hour maybe. I have so much data accumulated there.

(Off the record comments.)

MEMBER POWERS: Keep going.

MR. LI: Okay. The next slide I want to talk about is common cause failures and potential vulnerabilities at the site. A lot of damage was caused by settlement, especially the differential settlement, and soil failures at the site. For example, on the right you can see that picture which is an underground fire protection piping joint which is broken. So the water went away and also there are so many deformations, cracks in the ducts connected to the main stacks, and especially the fire caused under one of the transformer at Unit 3 which is due to the differential settlement at the foundation level.

And also potential interaction between different components and equipment, that's the next subject. For example, water leaking through the insulation layers, you know, broken insulation, seals and the damage to thermal insulator of SLC, it's called a standby -- control piping and it's not direct damage but damaged insulation. It's almost -- It could be damaged.

Okay. As I mentioned before I'm going to focus on the major findings from post-earthquake geophysical investigation. The TEPCO and the power plant spend a huge effort to investigate the earthquakes and the damage. They did a lot of geological surveys. They sent a boat to the ocean to get the seismic line of the submarine data and also deployed on land, on the surface seismic line, too. They dug boreholes at the site. They dig trenches. They did so much work to tell us what's going on there. Why we observed such a huge amount of ground motion at the different units here.

MEMBER ARMIJO: Did they know that fault was there when they designed the plants?

MR. LI: That's the next subject. Post-earthquake survey identified fault length was 34 kilometers, not seven as previously identified.

MEMBER ARMIJO: Okay. They knew something was there, but they didn't know --

MR. LI: Yes, the seven kilometer was identified in 1979. They submit that to the Nuclear Regulatory Commission in Japan. It was not the kind of big topic at the time because seven kilometers in terms of earthquake generation it's so small because you have a nearby source to consider, too. And the fault has a potential to generate a magnitude of 7.0 earthquake. So based on that 34 kilometers, I think it's conservative. It was embedded in the calculations there. I actually mentioned it's six point something, but they just -- For the conservative -- they just --

MEMBER APOSTOLAKIS: So when they thought it was seven kilometers, what was the potential at that point?

MR. LI: Seven kilometers?

MEMBER APOSTOLAKIS: When they thought it was only seven.

MR. LI: Yes, they just didn't -- it.

MEMBER APOSTOLAKIS: Oh, they just didn't --

MR. LI: Yes, because nearby there are many, many faults.

MEMBER APOSTOLAKIS: I see. So this was dominated.

MR. LI: Yes, Japan has so many natural faults in the whole land area, in the ocean area. Japan tops the -- The book called "Active Fault Atlas" they detail the faults in Japan because all the parameters in the trench digging, the information was there. You know, what's the activity, what's the -- They have so much detail to start with in the whole country.

MEMBER APOSTOLAKIS: Okay. Then the question is from all these other sources, what kind of activity do they expect?

MR. LI: In their design?

MEMBER APOSTOLAKIS: Yes.

MR. LI: Yes, they used like an earthquake occurred -- They used several. One is the faraway 7.0. The other one is closer by. They used several earthquakes to give, to define, the design earthquake. That's the previous story.

And it is a reverse fault. That's very important. It dips towards the power plant with an angle of 35 degrees and the nuclear power plant is sitting on the hanging wall side. I don't know if you can --

(Simultaneous conversations.)

MEMBER CORRADINI: It's on a shelf.

MEMBER SIEBER: It's on a shelf.

MR. LI: Yes, I wish we have a board here. But I can show you quickly here.

(Off the record conversation.)

Okay. This is the surface. This is where we come to the surface. There's a fault plan here with my angle is 45 degree, not a 35 degree. So if this fault moved -- This is called a hanging wall, this side. This is called a fault wall. So if the hanging wall moves up the wall like this like in Japan case, it's called reverse fault. If it moves down, it's called a normal fault.

MEMBER CORRADINI: Okay. (Indicating) So

it did that?

MR. LI: Yes. But the fault geometry and the relative moment determine the fault characteristics.

(Off the record discussion.)

So because this plant is located on the hanging wall side, so according to the major earthquake started around the world, the hanging wall usually has more concentration on the side of the waves. This happened in Kobe earthquake in 1999 and many, many like Turkey earthquakes and many, many earthquakes around the world. It's a recognized phenomenon. It also occurred here.

MEMBER CORRADINI: Is the Kobe a reverse fault?

MR. LI: Kobe --

PARTICIPANT: (Inaudible.)

MR. LI: Yes, it has some components of the reverse, but mostly a strike --

So based on TEPCO's study with those of efforts, they summarized. Extreme ground motion observed is because of the following factors. First is the source effect. That's what I mentioned, the reverse fault, the hanging wall effect there. The second one is called a deeper non-uniform layer formation and the third one is shallow old structure bending effect which caused such a significant ground motion at the seven units.

Let's look at this figure here. That's a summarizing map presented by Japan technical representative during the June 12 presentation. It says Factor 1, it's source effect. That's because of geometry of the fault relative to the power plant. It has 1.5 times the magnification to the ground motion. The Factor 2 was -- I'm sorry. Factor 2 is because a non-uniform of deeper ground foundation. It also indicates the level of the structure at about four to six kilometers beneath the surface. And then the Factor 3, it's due to the old bending structure. That's somewhere here. It's also highlighted near magnitude closer to the surface about two kilometers from beneath the power plant.

And it's -- We have some questions about this story here because the structure -- You know, the amplification of this step usually is caused by the thing called impedance contrast. Basically, it's the density multiplied by the velocity. But this can -- you know, if you don't have that impedance contrast, the wave packing through primarily results being effective.

And another thing is that there was another earthquake occurring 2004 on the east side of the power plant, not the west side. Those effects should be also, I mean, reflected by ground motion observed at the power plant. But we don't see any record or story about that. That earthquake was also 6.8 magnitude I should point out. And this is a common U.S. practice for -- industry a non -- facility is that use VS30, top 30 meter velocity to define the site characteristics. We never defined this deep by two kilometers of, you know, four to six kilometers. So we have some questions for our Japanese seismologists about those kind of issues. We're going to raise those questions to them.

Yes. There's still quite a lot ongoing activity at the power plant. They are doing non-destructive testing for hidden damage. You did the walkdown and you do the visual checking, but how about behind that? You could have some hidden problem there and their assessment of the new ground motion for the plant safety and thinking about how to upgrade this design for the power plant.

The key points about this earthquake at the power plant is that ground motion from the earthquake exceeded the design values of the KK plant, but all units are in cold shutdown and the plant systems worked as designed and radiological safety was not compromised and no damage to safety related structures and equipment but significant damage to the other structures and equipment.

MEMBER BANERJEE: I heard a rumor that one control rod is stuck somewhere, was stuck. Is that true?

MR. LI: It is. It's actually -- The control rod was stuck but after I think they did --

MEMBER BANERJEE: It may be stuck now. I mean, it may not --

MR. LI: No, actually these -- They did -- After I think manually they did something. They still work as it is designed. But there isn't a lot that actually jump out to support as I mentioned before.

MS. KAMMERER: But there were some fuel rods that were stuck and they did have -- But the control rod, what happened, there was some announcements that were just presented when we were at Kashiwazaki a couple of weeks ago that they found -- They did find that there are the guides, of course, and what they were -- what they found was it took about twice as long for all of the control rods to insert because what was happening was you actually had deformation of the guides and so it would kind of deform this way and you would have -- it would be bound and you would have some binding. As soon as it straightened out, then it would be free again and so it did take twice as long for the control rods to insert which was something that they showed through testing and analytical procedures and then they did have problems getting -- There are certain things and we actually have some pictures of some of it that we could provide to you. But, yes, that is something that we --

MEMBER APOSTOLAKIS: The reason why there was no damage to safety related systems even though they observed, they measured, several issues were found, is that because of the extent of separatism in their design?

PARTICIPANT: You bet.

MR. LI: There is an explanation from TEPCO. They said that the --

MEMBER APOSTOLAKIS: But we don't know how much it is.

MEMBER ARMIJO: I do.

MEMBER APOSTOLAKIS: You do?

MEMBER ARMIJO: Yes, I was involved in --

PARTICIPANT: There was --

MEMBER APOSTOLAKIS: Wait.

MEMBER ARMIJO: Their design practices are very, very conservative in every step of their process.

MEMBER APOSTOLAKIS: So I think that there's a public communication to say that this is a design acceleration -- It's just a number that initiates some process that adds a lot of margin.

MEMBER ARMIJO: That's correct.

MEMBER APOSTOLAKIS: Yes.

MEMBER ARMIJO: That's correct.

MR. LI: So it's a conservative design --

MEMBER APOSTOLAKIS: But how conservative is it though? In other words, if I go to another site, is the margin going to be the same or it depends on --

MEMBER SIEBER: Not necessarily.

MS. KAMMERER: One of the finding from -- workshop in Kashiwazaki a couple of weeks ago is that you could not extrapolate what happens at this plant to other places because it was very, very conservatively designed. So a lot of folks are saying, "See, this shows that this is true everywhere" and that's not the case.

Now right now, EPRI is actually assisting

TEPCO with a margins assessment because one of the things they need to explain to the regulators and to the international community is why was the performance good. It's great to say that it was, but we all benefit from learning exactly why that was the case and so EPRI is actually undertaking a seismic margins assessment right now that they've presented and that will be available.

MEMBER APOSTOLAKIS: The second question is which I think -- Why were the design values so much lower than what we measured? Was it a fault of the methodology that was being used or the way of the implementation of the methodology?

MEMBER BLEY: Or this just an extremely --

MEMBER CORRADINI: Data.

MEMBER BLEY: This is just an extreme earthquake.

MEMBER APOSTOLAKIS: I think you said that typically we go how many meters down and several kilometers to do the characterize of --

(Simultaneous conversations.)

MEMBER APOSTOLAKIS: But that's for big --

MR. LI: Our nuclear facility, we do a site specific --

MEMBER APOSTOLAKIS: So is the answer then that there is nothing wrong with the methodology? It's just that it was not implemented very well.

MR. LI: Well, it's already -- I think it's mentioned there. The key factors, this huge amount of ground motion of -- at the power plant site. It's underestimated the -- factor, that source factor. Second are those non-uniform layers and in the bottom --

MEMBER APOSTOLAKIS: But my question is why didn't they know about these things. Is it because they had a good methodology but they just didn't apply it very well or the methodology had holes that didn't ask them to actually look for these things? These are two different things. So what do you think the answer is? The methodology needs to be more complete, so to speak, or the methodology is fine but those guys when they did their own site characterization they didn't implement it very well. What is the ans

MR. CHOXI: George, I think one of the activities which is undergoing is to look at the standards for the design, how you come up with the earthquake. In fact, the next week we have representatives of Japanese government coming and talk to us about their new standards.

MEMBER APOSTOLAKIS: So you're saying that it was new standards that --

MR. CHOXI: -- the type of things we are seeing now.

MS. KAMMERER: That's right.

MR. LI: Probably it's a combination because --

(Simultaneous conversation.)

MEMBER POWERS: In reference to the best of our agenda, we're going to have to cut things off at this point. Thank you very much. It was a very useful introduction to the subject.

MR. LI: Thank you.

MEMBER POWERS: And it's clear that I see whole hosts of different implementations and I'm sure our seismic researchers see them, too. And it's going to be some time to start that up. Thank you very much for an exciting morning. As you can see that this is an issue the Committee has a huge amount of interest in and I think we should talk about a subcommittee meeting perhaps in the fall and as you complete your guidelines to Shack, we can sit down and discuss this research program some more.

Right now, just very, very worthwhile I thank you very much. Mr. Chairman, it is all yours.

CHAIRMAN SHACK: Okay. We're a bit behind schedule. But I think it's time to start the discussion of containment overpressure credit with TVA and Mario will be leading us through that.

(Off the record comments.)

CHAIRMAN SHACK: Need a quick five minute break. But be back at 11:30 a.m. promptly. Off the record.

(Whereupon, at 11:24 a.m., the above-entitled matter recessed and reconvened at 11:29 a.m.)

CHAIRMAN SHACK: On the record.

CONTAINMENT OVERPRESSURE ACCEPTANCE CRITERIA

VICE CHAIRMAN BONACA: Okay. Thank you, Mr. Chairman. As most of you are aware, the Tennessee Valley Authority submitted extended power uprate for Browns Ferry Units back in June 2004. This is requested in two steps five percent uprate for Unit 1 which is already been approved. It will be followed by a 15 percent -- power uprate for all three units.

In order to meet the requirements for all net positive (phonetic) suction for the ECCS pumps, the Licensee takes credit for containment overpressure. The Committee discussed the five percent uprate in 2007 and we recommended the application for five percent power uprate be approved.

However, we also noted in our letter that when the TVA would come for the 120 percent power uprate we would need to have more complete evaluations of two scenarios. One was the long-term LOCA. And the other was the Appendix R fire scenarios.

The concern we had with those two scenarios is that the amount of credit requested was significant and there was significant length of time. I remember that for the long-term LOCA the credit required was about 3 psi for up to a day, roughly 22 hours, and for the Appendix R it was up to 9 psi for up to 69 hours, almost three days, and, in particular, for Appendix R, the concern was that the difference between the available back pressure and required back pressure was only as low as 1.4 psi at some point in the transit. The concern also was that to achieve that 1.4 psi the operator was directed to turn off drywell cooling, maximize containment pressure, which is counterintuitive. So all these issues were on the table.

At that time, we also suggested some possible solutions for the issue. For the long-term LOCA, we suggested that the best estimate calculation to demonstrate their point that is that the credit was driven by the conservatism of the LOCA would be acceptable if, in fact, you were provided a best estimate with proper treatment of uncertainty.

For the fire analysis, we saw no solution except one in which you attempted to provide some kind of context, risk context, and we were interested in that. But the risk analysis was more qualitative and also was not complete. It did not include all fire initiators. We suggested actually in the letter that you protect a second kind of RHR as other licensees have done because that would cause no need for credit for back pressure. The other alternative would be to present a fire analysis that's complete enough to address all the initiators.

So, with that in mind, we did not hear anything from the Licensee since that time and we understand now that you provided some information to the staff in 2007. We have not received that. But today, we anticipated the staff and the Licensee will fully brief us when we come to the part of this in participation for the 15 percent uprate. However, your representation is an informal briefing to bring us up-to-date and to provide an opportunity to hear our comments and feedback.

Now we have received this information that it isn't -- and not ready to address as the full committee. So we intend to have an informal meeting with you rather to gather information and then we will see what it does to our thinking about what you've presented and the communication -- Okay. With that, I turn to Eva Brown of NRR to have --

MR. McGINTY: Good morning. Tim McGinty, the Deputy Director from NRR -- Dr. Bonaca, it's my privilege to introduce this topic to the Committee. Your remarks enveloped in its entirety all of my opening remarks.

(Laughter.)

So I wanted to save the Committee time. The intent is to allow a dialogue directly between the Committee and TVA regarding this topic. The staff, of course, is here to answer any questions that the Committee may have. But with that said, I'd like to turn it over to TVA, James Emens and J.D. Wolcott.

VICE CHAIRMAN BONACA: I'd like to clarify, however. We had a presentation to the Commission a month ago and, in their presentation, the point was made that one of the concerns is the difference of criteria that we are using versus the staff is using. That creates a confusion and hopefully we can come to an understanding between the staff and the ACRS in how we can deal with that.

MR. McGINTY: Yes, sir. And we are acting working on establishing criteria. So that is duly noted.

VICE CHAIRMAN BONACA: All right.

MR. EMENS: Okay. I'm James Emens, Licensing Supervisor of Browns Ferry. With me today is James Wolcott. He is the State of Power Uprate Engineering Manager and then we also have with us Bert Morris, Licensing Engineer.

And just like Mr. McGinty said, you captured the framework real well for this meeting. So I'll try not to repeat that. We are here to address the concerns that were experienced in the February 2007 ACRS meeting and we listed this on the first slide.

I would like to point out that this is related to extended power uprate and the extended power uprate does result in an increase of magnitude and duration of the licensing basis analysis for the needed containment overpressure. Containment overpressure has been a part of the -- licensing basis. It's currently a part of the licensing basis for all three units.

As you said, we heard your comments and we saw the need to do some additional analysis to address the Appendix R COP issue. In July of 2007, we met with NRC staff and had discussions regarding your comments. We undertook fire area analysis to compare the containment overpressure needed for a realistic fire versus the prescribed Appendix R fire. The deterministic analysis that resulted from that was submitted to the staff in November 2007 and subsequently performed the NPSH analysis to limiting cases in the fire area analysis and submitted that in June of this year.

And with that I would like to turn the presentation over to Mr. Wolcott who is going to do a detail of this analysis and address your concerns.

MR. WOLCOTT: I'm J.D. Wolcott. I'm the Engineering Manager for Power Uprate at Browns Ferry. Today's presentation is going to focus on the Appendix R fire event. That is what received the most analytical attention from us since the February 2007 ACRS meeting.

I start out by saying a little bit about Appendix R as it relates to this issue of containment overpressure. The Appendix R rule has us take a predefined, generic set of fire damage and then demonstrate that we can safely shut down the plant per a set of rules if it doesn't allow for a plant specific fire analysis to try to figure out what kind of fire you would have, what kind of damage you would have.

So it results in some areas of the plant in predicted fire damage that doesn't really match. It's overly conservative compared to how that part of the plant is configured and what it consists of.

MEMBER-AT-LARGE ABDEL-KHALIK: Before we get too far into the details of it, isn't that the law?

MR. WOLCOTT: It certainly is and we are --

MEMBER-AT-LARGE ABDEL-KHALIK: In a sense that, you know, if you had done an analysis for a large break LOCA and you found that your results do not meet the acceptance criteria, you don't come back to the agency and say, "Wait a minute. This is unrealistic. This is overly conservative. Let me show you the results of some other LOCA that meets the acceptance criteria." Is that the same logic?

MR. WOLCOTT: No, I have to cover -- I'm answering that question with this next bullet right here.

MEMBER-AT-LARGE ABDEL-KHALIK: Okay.

MR. WOLCOTT: So on slide five, we

performed another analysis as you say and it is not to take the place of the Appendix R analysis. We have -- It's a law. It's a rule and we have to comply with it and we have to show that there is a success path for safely shutting down the plant in accordance with those rules and we've done that. But it doesn't show very much margin.

So what the community was concerned about was the amount of risk involved, you know, associated with not having very much margin. And so we pursued a more realistic analysis that allows us to go into more detail in analyzing the plant and the purpose of that is to supplement the Appendix R analysis, the licensing basis analysis for the purposes of giving risk insights and showing how much margin is in the licensing basis analysis. So it's certainly does not take its place.

MEMBER APOSTOLAKIS: Is the causes analysis a risk analysis?

MR. WOLCOTT: No, it's deterministic. It's strictly deterministic for us to be able to look at the risk based on how much margin there is. It's not a numerical risk.

MEMBER APOSTOLAKIS: Measuring risk --

MR. WOLCOTT: It's not --

MEMBER APOSTOLAKIS: Are you going to do fire PRA before you say anything about risk or are you going to infer or conclude something about risk from the deterministic analysis?

MR. WOLCOTT: It is the latter. We are inferring risk insights from a deterministic analysis basically by looking at how much margin there is.

VICE CHAIRMAN BONACA: You do not have a fire PRA.

MR. WOLCOTT: That is correct. We do not.

MEMBER APOSTOLAKIS: But again, just understand something related to what Professor Abdel-Khalik said. These fire hazard analysis which is deterministic, is it allowed by Appendix R?

MR. WOLCOTT: No. No, it's not.

MEMBER APOSTOLAKIS: So you are trying -- You are being innovative here.

MR. WOLCOTT: We just are doing additional work to try to show how much conservatism is in the licensing basis approach.

MEMBER CORRADINI: A yes would have been fine.

MEMBER RAY: Wait a minute, guy. I think if it was over a noncompliance with Appendix R this would not be legitimate. What they're doing is doing an analysis to show margin as he said.

MEMBER SIEBER: Yes, on the other hand, is the importance of this to request an exemption?

(Simultaneous conversations.)

MR. WOLCOTT: No, it's not.

MEMBER APOSTOLAKIS: They are complying with Appendix R.

MEMBER RAY: They complied with Appendix R. It's just that's an emerging question.

MEMBER APOSTOLAKIS: And they are addressing this question because the ACRS is.

MEMBER RAY: That's right.

MEMBER APOSTOLAKIS: In other words, they could have told us we don't want to do it.

VICE CHAIRMAN BONACA: But my question here is that margin that you have in that specific -- to show us, that -- is still there. That's limiting licensing analysis. Correct?

MR. WOLCOTT: I think I would still agree with you that because that it is always possible to have that situation happen, it's not impossible, and the rule does require that we assume that that amount of damage occurs unless I can show you that it's impossible. We should show that we can safely shut down the plant given that scenario.

VICE CHAIRMAN BONACA: There was a reason why the letter we let persevere before you, but we were expecting at any time a fire analysis, a quantification, a PRA analysis that -- in fact, was the representation that you had a fire analysis because we see the quantitative estimation of 10^{-7} or something like that. And so it's important that we would like to see it but we cannot forget that you still are bound by the licensing commitment to -- the scenario.

MR. WOLCOTT: Absolutely.

VICE CHAIRMAN BONACA: Okay. Because you should.

MR. WOLCOTT: In this, we determined a fire damage by plant specific analysis versus what you would do in the rule which is a prescribed set of fire damage. This involves screening each of the 39 fire areas that we use at Browns Ferry using standard fire protection engineering principles, some of which are combustible loading in the compartment, the volume of the compartment, the amount of detection and suppression that is there and the ignition sources that are there.

MEMBER ARMIJO: Now are you talking about -- Do these numbers represent per unit?

MR. WOLCOTT: No.

MEMBER ARMIJO: Or --

MR. WOLCOTT: The entire plant.

MEMBER ARMIJO: The whole. The three units.

MR. WOLCOTT: That's 39 -- That's correct.

MEMBER ARMIJO: This is kind of all three units simultaneously being analyzed.

MR. WOLCOTT: That's correct. If we have to -- Because three units would be operating at the same time and we have to take care of them all. They're not all directly affected by the fire, by any one fire.

MEMBER ARMIJO: I understand.

MR. WOLCOTT: Except possibly the control room. But we have to handle them all any time --

MEMBER ARMIJO: Got it.

MR. WOLCOTT: With this screening by these principles, there are 22 of the 39 fire areas that screened out and what we mean by screened out is that because of the characteristics of the area that are listed the fire will be limited to the ignition source. That is that you don't have the mechanisms that would propagate a fire from the thing that caught fire to start with to other unrelated equipment. This would generally mean it would be limited to one division. And when you have a situation like that because of the redundancy and divisional separation that we already have you would have one division left and there wouldn't be an issue with shutting down the plant for those 22 areas.

MEMBER STETKAR: Jim, 39 fire areas per unit?

MR. WOLCOTT: No. For the entire plant.

MEMBER SIEBER: The whole plant.

MEMBER STETKAR: Interesting that there's only 39 fire --

MR. WOLCOTT: Well, some of them are pretty large.

MEMBER STETKAR: Yes, like maybe the whole turbine building.

MR. WOLCOTT: The whole reactor building.

MEMBER STETKAR: Because it would be interesting to see what those fire areas are.

MR. WOLCOTT: Some of them are quite large.

MEMBER STETKAR: Okay.

MR. WOLCOTT: Each reactor building, for instance, is its own fire area just about. So that --

MEMBER SIEBER: The whole turbine building would be one fire area.

MEMBER STETKAR: I was just curious. The thing that we call fire areas differs quite widely.

MEMBER SIEBER: Yes.

MEMBER MAYNARD: Depending on what their need is.

MEMBER STETKAR: Yes.

MEMBER APOSTOLAKIS: Now regarding the screening -- Let me understand this a little better. I think you are focusing on the fire itself in saying -- combustibles. So if I have a fire my deduction capability is great. You don't seem to be including anything regarding the damage to the plant and do I have both divisions going through that area? Do I have only one? Do I have none? Why is that so?

MR. WOLCOTT: That's the next slide. I have this kind of broken up on two slides.

MEMBER BLEY: Were some of the 22 areas that were screened out key areas in the original Appendix R file that led to this scenario?

MR. WOLCOTT: Yes.

MEMBER BLEY: Can you tell us which those were?

MR. WOLCOTT: The reactor, the one associated with Unit 1 reactor building, would be one of the places not where the Browns Ferry fire started but where it propagated to. When you screen one of these out the Browns Ferry fire would not be screened out. That fire was limited to the thing that caught fire to start with. But there was a lack of basic divisional separation involved in that incident which for a period of time affected more than one division because there are some cables that didn't meet separation criteria that was originally set out. So there were -- That fire would have not been excluded by this screening. It would have been limited to -- it was limited to what was --

MEMBER BLEY: Just to make sure I understand what you did. If you get into the fire area and you do have separation between your divisions in that area and there are no permanently installed combustibles that would link those two divisions, that room would screen out.

MR. WOLCOTT: Yes, transient combustibles count in this, too. They sure do. Some of these areas, the volume of the area, is probably a very important factor as is the detection and suppression. Some of these areas as you can imagine the reactor point is quite large compared to the amount of combustibles that you could conceivably put in that area.

MEMBER SIEBER: One quick question. In your screening process, one of the screening criteria uses detection and suppression.

MR. WOLCOTT: Correct.

MEMBER SIEBER: That typically is not allowed under the rule. Right?

MR. WOLCOTT: You could not exclude an area just because it had detection and suppression.

MEMBER SIEBER: That's right.

MR. WOLCOTT: The rule does include that, but couldn't just eliminate an area.

MEMBER SIEBER: Well, basically it's an insurance company that says you have to have detection and suppression and you'd like to know as a practical matter so you could send your fire brigade there. On the other hand, you can't count it under the rules.

MR. WOLCOTT: That's correct.

MEMBER SIEBER: So this third sub-bullet that you have that says you screen based on these fire protection parameters one of which is detection and suppression.

MR. WOLCOTT: You have to remember that we comply with the rule also but showing less margin in the result. So the purpose of this is to show that if you could relinquish some aspects of the rule you can show much more margins.

MEMBER SIEBER: Well, you get to the point where you say how effective is the suppression activity which is pretty much undefined even in the NFPA Code and so how did you treat that?

MEMBER APOSTOLAKIS: Would you remind me when that rule says -- I think as I recall it says that if you don't have the separation criteria then you have to do automatic detection/suppression. Is that correct?

MEMBER SIEBER: Yes. A barrier.

MEMBER CORRADINI: You have to have a barrier for a certain amount of time.

MEMBER APOSTOLAKIS: Yes. So that's basically what the rule says.

MEMBER SIEBER: Yes.

MEMBER APOSTOLAKIS: Mr. Sieber is right that it doesn't go beyond that.

MEMBER SIEBER: You have to have it.

MR. WOLCOTT: That's right. Correct.

(Simultaneous conversation.)

MEMBER SIEBER: You can't credit the barrier. You can't credit detections. He's correct.

MEMBER APOSTOLAKIS: Okay.

MEMBER BLEY: I'm new to this issue a little bit. Within the Appendix R rule, is there a definition of -- containment overpressure or is that coming from somewhere else?

MR. WOLCOTT: The Appendix R rule does not address that point.

MEMBER BLEY: At all?

MR. WOLCOTT: No.

MEMBER CORRADINI: So just to -- I'm glad you brought that up. So replay history back to the comments that Said and Mario made, given the situation at hand, you use that to justify some time period by which you need the overpressure credit to show compliance.

MR. EMENS: Correct.

MEMBER APOSTOLAKIS: Compliance with what?

MEMBER CORRADINI: Compliance but --

MEMBER APOSTOLAKIS: I understand now what you said. Compliance with --

MEMBER CORRADINI: They actually can satisfy the cooling under the condition of -- Make sure the pumps operate. They have to show the pumps operate for a set amount of time. Again, -- the NFPA for a set amount of time. That's what I remember.

MEMBER APOSTOLAKIS: I don't feel I'm

getting this. Is that what you mean?

MR. WOLCOTT: Yes. Did you want me to just go back a little bit?

MEMBER CORRADINI: No, I'm okay.

(Simultaneous conversation.)

MEMBER BLEY: -- for me is where does the acceptability of taking credit for containment overpressure come from? Where in the regulations are we anchoring that?

MEMBER CORRADINI: I think the history might be useful.

MEMBER BLEY: I need a little bit of history.

(Simultaneous conversation.)

MR. LOBEL: Richard Lobel from the staff. If you go back to regulation, it would be GDC 35 that requires abundant cooling of the ECCS. So the ECCS has to operate, has to put abundant water into the vessel. There is also a standard with UPM (phonetic) Section 622, Containment Heat Removal, and another GDC 38 that requires containment heat removal. So that would cover things like sprays and PWRs but not at Browns Ferry. Like somebody said, we're really talking about having the pumps available to do their safety function and it goes back to those two regulations, those two GDCs.

MEMBER BLEY: And they're kind of general in what they require.

MR. LOBEL: The issue of --

MEMBER BLEY: What they are accounting and not accounting for containment overpressure, does that show up anywhere in any specific guidance or anything?

MR. LOBEL: It's in the Regulatory Guide 1.82, Revision 3.

MEMBER BLEY: Okay.

MEMBER SIEBER: I believe the ACRS commented on that in the past.

MEMBER BLEY: I know. But I don't know -- I didn't know the history exactly.

MR. LOBEL: You commented -- It did come to ACRS for review, but it came to ACRS for review in the context of PWR some blockage and I don't think it really got much review by ACRS at that time because that wasn't what the staff was emphasizing. We came to you again with a Revision 4 to the Reg Guide which didn't go anywhere.

VICE CHAIRMAN BONACA: The Reg Guide 1.1 dealt with also back pressure.

MR. LOBEL: So containment accident pressure is necessary in some cases for some operating plants to demonstrate that they have adequate available MPSA so the pumps will operate and that's in Reg Guide 1.82. Thank you.

MEMBER BLEY: That helps me.

VICE CHAIRMAN BONACA: Okay. So you can proceed. So you did this 22 --

MR. WOLCOTT: That is correct. So in the screening, there are 17 fire areas, however, at the plant where the fire could propagate to unrelated pieces of equipment other than the one that caught fire to start with and by inference could affect multiple divisions, multiple pieces of equipment.

So for those areas, we had to go through and do an equipment availability analysis. In other words, we had to look at what equipment would not be affected by fire and try to determine how we would shut down the plant --

MEMBER-AT-LARGE ABDEL-KHALIK: Now in some of these cases this equipment's availability analysis did indeed show that you would only have one RHR pump.

MR. WOLCOTT: Right. Yes.

MEMBER-AT-LARGE ABDEL-KHALIK: If that is the case, if I look at the performance curves provided by your supplier, it said that all the performance data that you're using to evaluate the success was based on the average performance of all four pumps. In other words, they took the characteristic curves for all four pumps, came up with an average and that's what you used to establish your criteria. And yet if in some of your scenarios, you only have one pump available and this according to your estimate is sort of a realistic scenario, how can you justify using average characteristics in situations where you expect to have only one pump?

MR. WOLCOTT: I would have to do some research to try to figure out exactly where you're talking about there.

MEMBER-AT-LARGE ABDEL-KHALIK: I'm talking about page --

MEMBER APOSTOLAKIS: Sulzer report.

MEMBER-AT-LARGE ABDEL-KHALIK: It's the Sulzer report, for example, page seven of the report that is 37 pages. No, page three of 37. It says, "The basis for evaluation 35 witness desk performance curves for both pump sets were averaged to produce an average performance for each pump type." And that's what you use to find out whether or not you actually meet the criteria. So can you explain to me how you can use an average performance curve for four pumps when you only expect to have one pump available during the scenario?

MR. WOLCOTT: I believe I can if I understand it correctly.

MEMBER-AT-LARGE ABDEL-KHALIK: Please do.

MR. WOLCOTT: What they're talking about there I think is that they tested every single one of our pumps and it was a head flow test and reduced suction head test using a -- You've done on a test scatter and those are -- they are physical tests. And so when you do something like that, your data points, you have some data scatter any time you do that. So they took all of our pump tests where their NPSH determinations for all of our pump tests which are testing identical pumps, putting them on, running it all through the testing and like any experiment which has data and a data scatter, then they took the average of those tests and determined that NPSH that results at a one percent head loss and a three percent head loss.

MEMBER-AT-LARGE ABDEL-KHALIK: So are you trying to tell me that the characteristic curves for all four pumps are identical except for scatter in the measurement data?

MR. WOLCOTT: Because particularly when they did this test when the pumps were factory brand new, I would expect them to be very similar. I would have to believe there could be some machining tolerance or clearance tolerance that could make slight differences. But these were -- When these tests were done, these were factory new and assembled and probably very identical. But the tests reg and the test stand my intuition would tell me would introduce more error into that than the differences --

MEMBER-AT-LARGE ABDEL-KHALIK: Do you have indeed data to support that claim?

MR. WOLCOTT: We have all the tests data from these pump tests.

MEMBER-AT-LARGE ABDEL-KHALIK: These are 1970 something data. Correct?

MR. WOLCOTT: That's correct.

MEMBER-AT-LARGE ABDEL-KHALIK: Now the rotors were replaced in 1990 something.

MR. WOLCOTT: That's correct.

MEMBER-AT-LARGE ABDEL-KHALIK: And are you even sure that the 1970 something data is still valid?

MR. WOLCOTT: If the rotors -- The rotors were replaced in order to take care of wear ring cracking problem. It had to do with the material the wear ring was made out of. So the rotors are identical with respect to hydraulic performance.

They're trying to fix a material problem with them. So with respect to what we're trying to determine here, I have confidence that they will meet this requirement.

MEMBER-AT-LARGE ABDEL-KHALIK: So let me just cut to the chase. Do you have actual pump performance data post 1990 X for the four different pumps that shows that indeed they are identical, they are the same as the 1976 data and that the use of an average pump characteristic curve is justifiable in a scenario when you expect to have only one pump available and you have no idea which one of the four?

MR. WOLCOTT: The characteristic curves, that is the head flow curve, we determine that all the time and we have to test that all the time and prove that it's the same. But the curve that matters here is the net positive suction head curve. Typically, one only tests that once if they test it at all. So that's not a test that you would do periodically.

We have one test that's fairly famous in the industry that we did at Browns Ferry on an installed pump and we took it below the level, quite a bit below the level, that's in this curve in an attempt to figure out how far you can take it before you start having a true problem with NPSH pumping water and we took one of these pumps considerably below this curve we're using here and it worked fine.

MEMBER-AT-LARGE ABDEL-KHALIK: But my question --

MR. WOLCOTT: I believe that's the extent to which I can answer that. The other things that you're asking we do not have.

VICE CHAIRMAN BONACA: Go ahead.

CHAIRMAN SHACK: How big is the scatter in the data that you're averaging? I mean, if you have the raw data, you could tell --

VICE CHAIRMAN BONACA: The reason why this is an important line of questioning is again I mean you have such a little margin and that becomes important because we have to make sure that you don't have -- for long period of time under this scenario. So that's important.

MR. WOLCOTT: I think when we get along here we're going to find that is considerable margin. That's part of -- Part of the thrust of this analysis was to show that if we can forego just some of the unlikely aspects of the Appendix R rule that we were using in the licensing basis analysis that there's quite a bit of margin.

MEMBER-AT-LARGE ABDEL-KHALIK: But that's at our discretion. That is below.

MEMBER RAY: I think you're mixing up. You want to show that there was margin. The questions that you're being asked have to do with the compliance of the rule. So try and stick with answering those. And then in the analysis --

MEMBER SIEBER: And that's why I mentioned the fact that really what we're talking about is an exemption. You have a rule --

CHAIRMAN SHACK: No, he's going to meet Appendix R. The question is he wants to demonstrate to us that the amount of containment overpressure he needs is really low if we relax a little. But he's not really going to relax his Appendix R.

MEMBER BLEY: And I think this line of questioning is really getting at how can we have confidence in the margin that you're trying to --

CHAIRMAN SHACK: Which you're about to demonstrate.

MR. WOLCOTT: Yes.

MEMBER BLEY: It really is focused on that margin.

MEMBER RAY: There's margin in two applications. One is margin in the Appendix R case which they're not here seeking an exemption for as I understand it and that's a legitimate question to ask about. And then there's margin in the alternate fire shutdown analysis case which you'll see back here is big which they are going to talk about. But we can ask about the first case if we want to and I think that's where the questions are being asked go. They have to do with the different pumps because that's where the margin is small in the Appendix R case.

VICE CHAIRMAN BONACA: That's right.

MEMBER RAY: And so these questions are fair questions to ask, but that's not what they're here to present.

VICE CHAIRMAN BONACA: That's right. As I said, that is important to keep in mind that ultimately we have to deal with that or we have to hear from the staff as we have tried to do by one can say, "Well, it's an unlikely scenario. Therefore I don't really have to meet it."

MEMBER MAYNARD: This is not asking for an exemption. But they're claiming that they comply with the rule, that provided they get containment overpressure protection. They have a success path. We in the past have not been wild about that particular path of containment overpressure, but there's nothing in the regulations that prohibit that.

They also use operator action of maintaining the containment overpressure there which again there's nothing that prohibits that but things we've had questioned.

So by meeting the regulations, their margin is small and we're not excited about that. But they're not asking for an exemption to the regulation. What they're doing is showing if you take a look at reality, what they consider reality, we may or may not agree that it is, but there really is considerably more margin than what they can take credit in lieu of that.

MEMBER-AT-LARGE ABDEL-KHALIK: My line of questioning not only addresses the fidelity of how bad the situation is under Appendix R scenario. But in these so-called realistic fire scenarios there are two that also require containment overpressure credit and the question is whether the estimated relatively modest containment overpressure credits that they claim they need are really as low as they should be there.

MR. WOLCOTT: Yes, I think if we can -- We're more prepared to really talk about the realistic analysis here. So I feel confident in saying that the amount of uncertainty, if you will, that would be in the determination of NPSH is well within the noise band of the amount of margin that we show between how much containment pressure you would expect to have and how much containment pressure is needed.

MEMBER CORRADINI: So just so that -- It sounds like we're still doing this. So I think to at least address Said's question that you guys ought to take an action item to at least get back that data so that we know what it is. Because if you can't tell us what it is now but you have it somewhere --

MEMBER BANERJEE: I see this as more like a best estimate calculation but then you need to know the uncertainties.

MEMBER MAYNARD: I really think we should let them -- We're not required or not being requested to make an decision today. This will come back up again with the power uprate. So they're going to be providing us information --

CHAIRMAN SHACK: I understand but --

MEMBER RAY: I want to insist that if you come in here and make a presentation they're making they have to be prepared to answer questions that are being asked that apply to Appendix R compliance. I mean, that's just fair. It just seems to me like the questions that Said is asking go more to are you in compliance, can you show you're in compliance, than to the acceptability of this alternate that they're here to present.

MEMBER-AT-LARGE ABDEL-KHALIK: Well, it also addresses --

CHAIRMAN SHACK: We've identified an issue that will have to be addressed later. So I think we can move on.

MR. LOBEL: This is Richard Lobel from the staff. Let me make one more comment and of course they can correct me if I'm wrong. But I believe the Sulzer report you have to keep in mind it's a pump vendor report and if I remember right they have, they use, data that was available to them besides the Browns Ferry pump data. So just looking in detail at the points on a Browns Ferry pump curve from that testing isn't going to be the complete story that the pump vendor used to --

MEMBER-AT-LARGE ABDEL-KHALIK: This is a very specific statement in the report that I read that says, "As a basis for evaluation certified with these test performance curves for both pump sets were averaged produced an average performance for each pump kind."

MR. LOBEL: Right. But when they go

further and they develop those curves of how long you can stay at a given amount of required NPSH I believe that included other pump data besides Browns Ferry's pumps.

MEMBER-AT-LARGE ABDEL-KHALIK: That makes the situation --

MR. LOBEL: And that's what's used in the actual analysis.

MEMBER-AT-LARGE ABDEL-KHALIK: That makes the situation even worse because if they are averaging over a large number of pumps and there is a large variability I have no idea where your pump falls in that step.

MEMBER RAY: And I still say that's a compliance issue. As Bill said, it's going to have to be revisited.

MR. WOLCOTT: We'll have to prepare --

MEMBER RAY: We have to move on.

MEMBER BANERJEE: Can we table that for God's sake?

VICE CHAIRMAN BONACA: Go ahead.

MR. WOLCOTT: We're now on Slide 6. To do an equipment availability analysis, I'll back up a little bit, we determined 17 fire areas where you could get more extensive prior damage just due to the characteristics of the area and so for those 17 areas we looked at all the equipment that was either located in the area or got power from the area or had a cable routed through the area, etc., and determined what equipment would be lost or more importantly what equipment would be unaffected. Then we used that unaffected equipment per the emergency operating instructions (EOIs) like we would do whether we had a fire or not to shut down the plant. In this analysis, unlike our licensing basis Appendix R analysis, we took credit for having offsite power if offsite power was affected by the fire. In our Appendix R licensing basis we arbitrarily assumed that offsite power loss.

MEMBER STETKAR: When you did that, I hate to belabor details, but it's important to understand how we got down from a power of 39 to two. Did you look at the effects of fire induced hot sources where the signals could trip?

MR. WOLCOTT: Yes, we did and that does --

MEMBER STETKAR: Yes is good enough. Thanks.

MR. WOLCOTT: Okay. Having offsite power, the difference that made, it goes a little bit to your question. Many of the fires in these areas do take offsite power away from the safety related equipment just because of that reason. But it does leave offsite power to the balance of the plant equipment because that's quite remote physically.

MEMBER STETKAR: I just wanted to make sure that you looked at this.

MR. WOLCOTT: Yes, we did.

MEMBER STETKAR: Thanks.

MR. WOLCOTT: And so we used balance of plant systems when they are available as we would normally. So with that analysis --

MEMBER CORRADINI: I'm sorry. You were saying and I'm hearing, but I'm not getting it. So far I understand what you said about two fires need to obtain overpressure credit.

MR. EMENS: Yes. Correct.

MEMBER CORRADINI: So that means there's a equipment -- I'm not following that.

MR. WOLCOTT: You are two notches ahead of me on the slide.

MEMBER CORRADINI: I'm sorry. Okay.

MR. WOLCOTT: There are 15 of these 17 fire areas. When you look at equipment availability, there's enough equipment available that you would not need containment overpressure because the temperature doesn't get high enough. This would mean that you either have more than one RHR pump or that the condenser is available and that's where the heat goes to the condenser. It's different things for different areas.

But there are only two fire areas in the plant where there would -- you would possibly need some containment overpressure. That would be if you lost everything in the room and it was hot weather and the river water was warm. Then with other conditions being bounding, you could need some containment overpressure.

That addresses something else we kind of touch on a little bit. These are bounding analyses, but they are best estimate. They still take all the assumptions to their, what I call, 95 percent non-exceeding value which they've never been higher than that 95 percent. So they're from plant data.

These two areas are both electrical board rooms. They have switch gear in them and one of them is on one of the units and one of them is on another and each of them affects its own unit.

MEMBER CORRADINI: So may I just go back to the rule that was originally discussed just for ratification. So just to cut to -- So if you were to protect these areas you would essentially protect parts of the train of equipment. Am I understanding correctly?

MEMBER SIEBER: The issue would go away.

MEMBER CORRADINI: The issue would go away. Thank you.

MR. WOLCOTT: If we could separate them to the Appendix R rules, then in Appendix R compliance the issue would go away.

MEMBER CORRADINI: Okay. That's fine. I just want to make sure I got it. I got it.

MR. WOLCOTT: Okay. We're on Slide 7. The two areas that could meet containment overpressure are characterized by resulting in the minimum amount of equipment available that you use to cool the core and cool the containment and so those were used to define the scenario, the limiting scenario, that would be used to calculate net positive suction head and containment overpressure. So they form the design basis cases, if you will.

In those areas, we do not have -- The unit that's affected doesn't have access to the condenser. So all the heat goes into the containment. They do not have high pressure injection. So we have to depressurize the reactor with low pressure systems.

What they do have is emergency

depressurization which is what we do initially is depressurize the reactor and then we use the balance of plant systems as we would if we didn't have a fire as the preferential system to control and maintain reactor water level. This would be the condensate system and we would use the one RHR pump to cool the containment and suppression pool cooling motor.

One of the big differences or a couple, I'll kind of go over the big differences here between this and the licensing basis Appendix R analysis with respect to how it affects containment overpressure. One of them is that because the water in these events is coming from outside of the containment, whereas, in the Appendix R event we just default to circulating internal containment water, that the volume of water inside the containment increases throughout the duration of the event and so it's heat capacity increases as the event continues and it keeps the temperature from getting high. In other words, it lowers the temperature profile.

The second thing it does is it increases the elevation of the water above the eye of the pump as the event progresses and that adds to the available, directly to the available, net positive suction head. So those two things give us an advantage in real net positive suction.

VICE CHAIRMAN BONACA: This is the use of the CRD pump. Right?

MR. WOLCOTT: The CRD pump is going all the time in the background because of the control rod drive system.

VICE CHAIRMAN BONACA: In the back.

MR. WOLCOTT: We're using --

MEMBER CORRADINI: They using condensate --

MR. WOLCOTT: And we're using a condensate system that has an automatic level controller that would just control the level of this. So they combine together. One of them has a level controller and the other just puts water in.

The other thing that we changed for this analysis relative to licensing basis analysis that makes a big difference is a relaxed NPSH required curve. We've already talked about that a little bit. The licensing basis curve we use which is as some of you may remember is a time stepped curve that allows you to run at reduced NPSH for shorter periods of time is based on a total operating life if you were to have an accident situation of 8,000 hours because all of this relates back to wear and tear of the pump.

For this analysis, we shortened the duration in the event that we would expect this to work to be commensurate with the regulatory driven duration of the event which is 72 hours and relooked at how much net positive suction head we can operate at and that allowed them to drop back to the Hydraulic Institute's three percent head loss curve which is used as a defined minimum net positive suction head. So the curve we would use in the licensing basis is quite a bit above the three percent curve.

VICE CHAIRMAN BONACA: Once around it uses 7,000 gpm. Right?

MR. WOLCOTT: We're also operating at a slightly lower flow in this operating mode which is also an advantage.

VICE CHAIRMAN BONACA: Which means that the pump is --

MR. WOLCOTT: No. Yes. I could go through that a little bit. The way -- This is all in the Sulzer report. In fact, I can kind of thumbnail through it. The way they approached this is they start out by calculating the NPSH that you need to have to have zero cavitation operation. For this pump, that's quite high. That's something like 70 feet. And then they compute a recommended, normal operating NPSH required which does have cavitation involved all the time and it is based on operating the pump for 40,000 hours which for a standby pump like this is an eternity. You would hard to get 40,000 hours on there. So that's -- for this pump at these flow rates, that's something like 30 feet and then for an accident where you're not going to try to -- You may have to do maintenance on the pump after that. For a standard design basis accident, we have kind of adopted 8,000 hours of operating time as --

MEMBER-AT-LARGE ABDEL-KHALIK: A question for you.

MR. WOLCOTT: Yes.

MEMBER-AT-LARGE ABDEL-KHALIK: The cavitation free net positive suction head required cable that's provided by the vendor for 12,000 gpm gives a value of NPSH required of 75.3 feet. The vendor cable for the same condition has a recommended NPSH which corresponds to 40,000 hours of operation. It's 99.8 feet. So how can the recommended NPSh required be greater than the cavitation free NPSH required?

MR. WOLCOTT: They might be of different flows. I would have to study that.

MEMBER-AT-LARGE ABDEL-KHALIK: For the

same flow.

MR. WOLCOTT: That doesn't make sense.

MEMBER-AT-LARGE ABDEL-KHALIK: It doesn't make sense.

MR. WOLCOTT: Yes.

MEMBER-AT-LARGE ABDEL-KHALIK: So how can I have confidence in this vendor report?

VICE CHAIRMAN BONACA: Well, I think it would need to have some clarification before -- I mean this question -- I have another question here that goes to the report. There is a statement that says that Appendix R one of NPSH for RHR pump must be 17 feet and 9,000 gpm, so a 70 hour event duration which implies that we can go 70 hours. When I go to curve two it shows that for the 35 feet which is higher if you are below that, your -- hours before you lose the pump is 10 hours.

MR. WOLCOTT: Curve two isn't the time curve. Curve two is based on how much head loss you experience as you reduce net positive suction head of different flows and then the time dependent curve s were generated mostly by Sulzer's experience about how much wear you get on something as you increase cavitation. So they are really two different parameters we can get with that if I understood your question.

VICE CHAIRMAN BONACA: Curve three shows 25 feet -- and the life is 10 hours for that.

MR. WOLCOTT: Yes. Curve three is the licensing basis curve which would say that the -- would be based on expecting a problem free operating life of 8,000 hours.

VICE CHAIRMAN BONACA: Yes.

MR. WOLCOTT: With this event included in. In other words, if you've operated it in this condition, because this is all -- as long as you've not gone past the point where the pump won't pump, then all of this is a matter of trouble free operation lifetime.

VICE CHAIRMAN BONACA: But still you will have to look at the report more in detail because it's rather informational and you are telling me that in fact the relaxed NPSHR there is a cavitation taking place.

MR. WOLCOTT: It may be helpful. I don't know if it would be. All of this data and curves that we're looking at here are the same thing that was used to establish the licensing basis. The difference here is that Sulzer took the same data, the same curves, and made an additional requirement for a shortened lifetime which gave a lower number. The data, the tests, the curves, they're all the same thing that the licensing basis is based on. They're not new.

VICE CHAIRMAN BONACA: I'm not saying that. I'm only saying that the scenarios represented as you are having a response cavitation for period of times. Okay?

MR. WOLCOTT: That's correct.

VICE CHAIRMAN BONACA: And if you look at it, I mean, clearly you are using even in the more favorite scenario, you are using equipment outside the normal design mode of operation. You are doing it because you have -- you need that NPSH credit.

MR. WOLCOTT: But --

VICE CHAIRMAN BONACA: That's not normal and so we need to be confident that, in fact, under those conditions the pumps will work and will perform their functions.

MR. WOLCOTT: That's right, but when Sulzer applies a pump normally, their normal application recommended curve does have cavitation associated with it. It's just an amount of cavitation that won't be a problem with the pump for 40,000 hours, if you just operate it that way with that amount of cavitation for 40,000 hours.

MEMBER MAYNARD: I'd like to suggest. I don't think we're going to get the answers to the questions that we're asking here. I do believe it's an important topic and the next time we meet on it it would be helpful if you had an expert, somebody familiar with the reports and maybe be able to answer some of these questions. I think we're going to go round and round in circles in the pump.

VICE CHAIRMAN BONACA: I try to get information on that because that's what the meeting is for.

MEMBER BLEY: I would like to toss one more in and not to get an answer now, but just a couple points on the Sulzer report that had me a little confused and maybe later we can clarify it somehow. One is they say the original test records were lost and they didn't even use them. So it wasn't clear to me they were using just Browns Ferry data and they didn't have the original.

The one that Said pointed out, the two tables on cavitation free and recommended for the RHR pumps show much lower head required or recommended except at 12,000 gallons which it's an anomaly. So something is wrong with that. Find out what's wrong with it.

The last, my third point, is I'd really like to see something on the uncertainty in these results and the scattering of the data and uncertainty in these projections and times before the pump is really damaged. There's none of that in here that I see.

MR. WOLCOTT: We'll come back and look at it.

VICE CHAIRMAN BONACA: Let's proceed.

MR. WOLCOTT: Okay. The final thing on the slide is that in this analysis we are not determining, not shutting down the drywell cooling. Our EOIs don't direct us to do that. That's something we're doing in that the Appendix R specific safe shutdown analysis. In the EOIs we would not do that and in this analysis we don't need to do that. So we're --

VICE CHAIRMAN BONACA: Do you have separate procedures for Appendix R?

MR. WOLCOTT: Yes, once you've determined that the condition of the plant has gone beyond a certain point, then you exit the EOIs. This is common for BWRs. You exit the EOIs and go into a very specific Appendix R safe shutdown that is different depending on where the fire is and it's no longer symptomatic. It's just the fire is here. You do this.

MEMBER BLEY: Can I -- Let me ask you a question about that because in the Appendix R analysis I'm not sure exactly how you did it. But when did you assume you'd be shutting down the cooling to maintain the pressure and does that align with the way the procedures would shift you over to the Appendix R procedures?

MR. WOLCOTT: In the Appendix R analysis and its procedures, everything is timed. The scenario is timed and what the operator has to do is timed. And so he knows when he has to do it and everything is assumed to be lost at time zero. I mean, at time zero, the plant's SCAMs are cut off from the heat sync and nothing works until you go and do the -- In that analysis, you would be cutting off the cooling rather quickly or in the real event. If it somehow got to this one, it would be much later in time.

MEMBER BLEY: That's true.

MR. WOLCOTT: So you would already heated up some probably. We don't take credit for that one. This realistic analysis also assumes everything is lost at time zero and we have to proceed from there. Really the difference is how we proceed from there.

MEMBER BLEY: Okay.

MR. WOLCOTT: So we are not terminating drywell cooling.

The results of this analysis we'll look at in the next slide. But the results of this analysis are we need about a half a pound of containment overpressure and the duration of containment overpressure is about six hours. Again, this is with the hottest river water temperature we've ever had. On an average day, we would not need containment overpressure because the river water temperature makes a big difference.

There is also significant margin between the containment overpressure that would be required and the minimum containment pressure that would result.

MEMBER-AT-LARGE ABDEL-KHALIK: Now you provided a table comparing conditions or boundary conditions used in doing this analysis vis à vis the licensing basis analysis.

MR. WOLCOTT: Yes, we did.

MEMBER-AT-LARGE ABDUL-KHALIK: And there are several differences obviously. The first one is initial drywell pressure. The licensing value is 15.5 pia. The value used in this analysis is 15.9 pia.

Second, RHR heat exchanger k-value the licensing basis 227 BTU per second degrees f. the value used here is 241.

The flow rate, you're assuming that you're going to minimum flow rate in this analysis with 7,000 gpm versus 9,400.

You're assuming that the horsepower has correspondingly reduced and therefore you have less need for heat removal from 2,000 horsepower down to 1,600.

You're also assuming an RHR pump required NPSH of 17 feet. Where do all these numbers come from? Do you have the data to support all these changes?

MR. WOLCOTT: I think we talked about the 17 feet. Things like the flow rate, that is a symptom of the mode that you're operating in. Because in the Appendix R licensing basis analysis, we go straight to a very specific procedure that has a stow-in to what we call alternate shutdown cooling which is a different path and in that procedure we are not able to control flow. We control back pressure in the reactor and the flow could be as high as 9,000 gallons.

However, if you're in suppression pool

cooling where we have specific operating instructions to tell you where you can operate and so you wouldn't be allowed to operate 9,000 gallons.

MEMBER-AT-LARGE ABDUL-KHALIK: So how about the heat exchanger performance? This value of 241 is obviously above tech spec limits.

MR. WOLCOTT: It's above the limit that we use in the licensing basis analysis. We don't have a spec tech requirement per se on that. The one that we use in all of our accident analyses is based on some heat exchanger tubes that got damaged once and it made its way into the licensing basis and we just reserve that margin. That heat exchanger got fixed then, but we just -- we preserve that amount. It's common for us to do that in licensing basis is preserve amounts of margin as we need to use them for something else. That's why we do that.

MEMBER-AT-LARGE ABDUL-KHALIK: I think the point I'm trying to make is that there has to be a justification, supporting data, for any changes in the assumptions that you've made in the analysis.

MR. WOLCOTT: Absolutely. And those are summary results of an official calculation and that calculation has to document all the assumptions.

VICE CHAIRMAN BONACA: Okay.

MR. WOLCOTT: And then the final point on this slide is that and the way we would really do this, containment or core cooling is not dependent on containment overpressure and that resolves an defense-in-depth issue that you would have with containment overpressure in that if you're just using the one pump from the suppression pool then there's a linkage between containment integrity and cladding integrity that would call up a common question.

The next slide is a plot done in similar fashion to our licensing basis analysis which shows us the results of containment overpressure in this particular analysis. The upper blue line is the suppression pool temperature. It peaks at about 208 degrees in about six hours.

The next line down which is the red line is the minimum containment pressure that you would expect to get considering shifting assumptions so that they create minimum containment pressure. That's a requirement of Reg Guide 1.82.

And then the most important line is the lower green line. That is the containment overpressure line and that is defined as the amount of containment pressure that is required to make NPSH available exactly meet NPSH required which in this case is 17 feet. So any place that that green line crosses the dotted atmospheric pressure line is what is defined as containment overpressure.

MEMBER-AT-LARGE ABDUL-KHALIK: So if you were asked to put error bars on your green curve as a result of either the assumptions or parameters used in the analysis, uncertainties in the assumptions, or parameters used in the analyses, or uncertainties in the equipment performance would you be able to do that?

MR. WOLCOTT: These are bounding analyses. So the error bar would all from that green curve would all hang down.

MEMBER-AT-LARGE ABDUL-KHALIK: Not necessarily bounding.

MR. WOLCOTT: Every attempt is made here to make these bounding analyses. It doesn't mean that there's something that somebody could identify. But they are intended just like a licensing basis analysis to be bounding. They're just not as bounding as a licensing basis analysis and they're based in -- The big difference here is this is based on a different scenario.

MEMBER RAY: Wait a minute. He's talking about the green line and you guys earlier conceded I thought that what you read was accurate that it was error.

MR. WOLCOTT: Yes. There's certainly an uncertainty in the 17 foot number.

MEMBER RAY: That's right. You know, I mean, just like turn the page to the next one and put the -- The concern originally stems from the margin between the green line and the red line on the next page. But it's the same error bar.

MR. WOLCOTT: It would be the same error.

MEMBER RAY: Okay, and that's what he's asking about. So let's focus on the question.

MEMBER MAYNARD: It may very well be conservative, but I don't think you've demonstrated that and especially with the discussion we had on some of the other things on addressing the error bars for the pump.

(Simultaneous conversation.)

MEMBER MAYNARD: Unless there's a -- someplace else, I think you have to tie that in.

MR. EMENS: I think it's not typical in any accident analysis that there are parameters that we pick out and make them bounding or very conservative and there are others, for instances, scatter on a pump head flow curve that we wouldn't and even a LOCA analysis try to account for it specifically.

MEMBER MAYNARD: I think you need to be able to convince us that that does bound uncertainties --

MR. WOLCOTT: That it's bounding.

MEMBER BANERJEE: The thing that concerns me more is actually the Appendix R calculations. What is Said is saying is right. What is the error bar on the green curve there? That's a compliance matter.

MEMBER RAY: Right. You're raising this issue here, but you're inevitably exposed to this question.

MEMBER BANERJEE: Yes. I really care about that. I really care what happens to that green curve and the other curve. It's all the issues you're rephrasing right now.

MR. WOLCOTT: Our licensing basis analysis needs to be a bounding analysis and this more realistic one is intended to certainly be a bounding analysis.

MEMBER BANERJEE: But more interesting is what happens if you put the error bars into the green curve there.

MR. WOLCOTT: You're looking at the next

page. On the next page.

MEMBER BANERJEE: Sorry. The next page. Yes. Sorry. That's where I'm concerned.

MR. WOLCOTT: We still don't have any error bars for you --

MEMBER BLEY: Now I have a question.

MR. WOLCOTT: Are we done with Slide 9 curve and ready to move to 10?

MEMBER BLEY: On this one, if my memory is not failing me, this is not the same curve we saw some months back.

MR. WOLCOTT: This is the exact same curve.

MEMBER BLEY: Because I thought the margin between containment pressure and required pressure dropped down real close to just a couple psi.

MEMBER CORRADINI: Pretty close.

VICE CHAIRMAN BONACA: That was in the early phase --

MEMBER BLEY: That's what you have there.

MR. WOLCOTT: There's a point in time where they come rather close.

MEMBER BLEY: Okay. It's just early. I thought it was later too. Yes, you do, but I thought out here there was --

MEMBER BANERJEE: If you take the uncertainties in your pump behavior and you put it on there, what happens?

MEMBER-AT-LARGE ABDUL-KHALIK: That's what we would like to find out.

MEMBER BANERJEE: Right.

MEMBER CORRADINI: So you're not prepared -- no. Silence is telling me you're not prepared to do it right now. But what we're also telling you back is you'd be prepared either sooner or later or we're going to keep on talking like this.

MEMBER BANERJEE: I know the other calculations are interesting, but this is the licensing basis.

MR. WOLCOTT: Yes. What I'm taking away from here is that we want confidence that we're complying with the licensing basis curve if that's the gist of the question and to make sure that these are truly, this analysis is truly, a bounding analysis. I think that that's the heart of what is being brought up here is that --

MEMBER RAY: I would say you're not getting any feedback yet on the page nine picture. Is that right? No, we're not giving you any feedback on that now, but we are on page 10.

CHAIRMAN SHACK: No, I think on page nine you also need to address the answer because --

MEMBER RAY: It's the same issue.

CHAIRMAN SHACK: It's the same issue.

MEMBER RAY: I mean, there's more there than just the issue that is so obvious on page 10.

MEMBER SIEBER: Right.

(Simultaneous conversation.)

MEMBER RAY: It's more though than just the uncertainty on the green line. It's also is that enough margin given everything else.

VICE CHAIRMAN BONACA: Yes.

MR. WOLCOTT: Any more comments on the curve on page 10? That's pretty much the --

VICE CHAIRMAN BONACA: One thing that I spent some time looking at the other curve of the vendor report and looking at page nine to understand what is the chance that you have to cavitation at these pumps would be this type of scenario.

MR. WOLCOTT: Yes. These --

VICE CHAIRMAN BONACA: Because of the relaxed mode as they call it.

MR. WOLCOTT: During these event we would be below the licensing basis vendor curve for about 10 hours and then you're back on the right side of it again. The two curves are a little bit hard to compare because the licensing basis curve is a function of time.

VICE CHAIRMAN BONACA: Yes. No, I understand.

MR. WOLCOTT: And this realistic one is not. So there is a little bit of --

VICE CHAIRMAN BONACA: This is ECCS pumps.

MR. WOLCOTT: Yes.

VICE CHAIRMAN BONACA: You want them run for the time that you need them.

MR. WOLCOTT: Absolutely.

VICE CHAIRMAN BONACA: And so I would have to feel comfortable that to believe that even if they are degraded somewhat you still are going to get the flow that you need and they're going to run. Already for the short time LOCA, you're showing three or four minutes of cavitation even with full credit for back pressure.

MR. WOLCOTT: Correct.

VICE CHAIRMAN BONACA: So now you did the test and I believe that and I look at the report and the results statement. Still that's not the mode to operate these pumps. Okay.

MR. WOLCOTT: Are we done?

VICE CHAIRMAN BONACA: Let's move onto 11.

MR. WOLCOTT: Okay. I'm on slide 11.

We've -- Going through the Committee's letter on Browns Ferry Unit 1 of February 16th, the Unit 1 recommendation letter, there are several issues that we extracted from there and tried to call out individually. One of them is the feasibility of protecting a second RHR pump for the Appendix R.

VICE CHAIRMAN BONACA: The reason by the way why we suggested this is that that's what Vermont Yankee did and now the licensees are done.

MR. WOLCOTT: Vermont Yankee protected a second service wire building.

VICE CHAIRMAN BONACA: That's true.

MR. WOLCOTT: They still are using only one RHR pump.

VICE CHAIRMAN BONACA: But they did that.

MR. WOLCOTT: But they're mechanically designed a little bit different.

VICE CHAIRMAN BONACA: Designed different.

MR. WOLCOTT: That's right. So we looked at protecting a second RHR pump during the recovery of Unit 1 before the ACRS meeting and then when it was brought up as an important point in here we looked at it again afterwards and the conclusion is that it would take extensive resources to try to protect a second RHR pump at Browns Ferry and I have on here a couple of reasons.

One of them is the physical location of switchgear in a couple of the electrical board rooms is such that in order to get Appendix R fire separations a major piece of equipment would have to be moved to probably a new room, a newly created room. That would be a challenge there.

A second one is that Browns Ferry has a shared electrical system which is not very common. And so everything we do to try to mitigate a particular event on one unit still has the constraint of mitigating all the other things that designed for on the other units.

PARTICIPANT: And mostly Units 1 and 2. Right?

MR. WOLCOTT: Yes. So that presents an obstacle in the way of flexibility to redesigning the system.

Thirdly, when we bring in a second RHR pump we're talking about bringing in considerably more equipment than just that to support it. The RHR pump, of course, would have valves and controls for the valves that would have to be brought in. The biggest hitter would be a diesel generator. These generators are only big enough to power one RHR pump. So if we bring another RHR pump into the fold we have to bring a diesel generator into the fold. That machine has a lot of support equipment and a lot of support circuitry and a lot of controls that would have to be brought into the Appendix R separation fold, not just in one location, but everywhere.

And then we would have to bring in an additional service water pump and its power supply, its valves and its controls. So there would be significant modifications involved, mostly having to do with rerouting, wrapping, a protecting cable and some of which would be physically relocating major components.

There would also be significant changes to the program because how we would go about accomplishing an Appendix R safe shutdown would be different if we were to have to align a power and operation of that second RHR pump and that would almost certainly involve some relicensing. So it wasn't -- For us, it wasn't a straightforward change, say, like it was at Vermont Yankee.

Based on having done an analysis that basically shows that we're not going to actually get there in an event that's as severe or has little margin as what is shown in the licensing basis analysis, it wouldn't be beneficial to try to modify the plant to that degree because of the other things that --

MEMBER-AT-LARGE ABDEL-KHALIK: You know, this is an assessment that you have to do. It doesn't matter what resources are needed to do this. If that's what it takes to meet the requirements of the law, that's what it takes to meet the requirements of the law.

MR. WOLCOTT: Absolutely. Our position is we comply with Appendix R now and with power uprate already this is part of our licensing basis. Containment overpressure is currently part of our licensing basis for Appendix R. The power uprate issue that's under review makes the number higher and the duration longer. Currently in Appendix R --

VICE CHAIRMAN BONACA: The fact that you're already -- for it doesn't do any good.

MR. WOLCOTT: So we comply now. Otherwise, we would have to do a --

MEMBER-AT-LARGE ABDEL-KHALIK: I'm sorry. You have not demonstrated that today. Right? Because if I don't know what the uncertainties in the green curve for the Appendix R scenario, I do not know whether or not you meet the requirements of the law even with full credit for containment overpressure.

MR. WOLCOTT: And that's our obligation to demonstrate that. We just didn't -- That wasn't the thrust of our presentation today. But we can certainly focus on that.

MEMBER MAYNARD: Does your current licensing basis also include the required operator action to secure RHR or is that new for the power uprate?

MR. WOLCOTT: It's newly discovered. We would have to do it in the current licensing basis and we just didn't know it. So it was discovered as part of the power uprate review and so we handled that as a corrective action issue and had to implement that in plant now. But it wasn't at the time because we didn't realize it.

MEMBER BLEY: Just a question on history. In the recent report you focused on, you said historically you had to take credit for containment pressure. Is that even before the first power uprate?

MR. WOLCOTT: Yes.

MEMBER BLEY: So all along.

VICE CHAIRMAN BONACA: It's tied to Sulzer scenario. Right?

MR. WOLCOTT: No, in Appendix R, containment overpressure credit dates back to when Appendix R was originally granted which would have been the late '80s.

MR. EMENS: 1988 is when it was approved.

VICE CHAIRMAN BONACA: And the report said it was introduced for the first time --

MR. WOLCOTT: For a LOCA.

VICE CHAIRMAN BONACA: Yes. For a LOCA.

MR. WOLCOTT: The reason that is because the suction strain ratio had to do with plugging the strainers and that had a big effect on NPSH. In an Appendix R event, there's plenty of strainer to go around. That's really not the limiting thing.

VICE CHAIRMAN BONACA: No, but I mean as I was reading the report, there is an implication that since you already got some credit for it you were authorized and you were entitled to additional credit. But there is a limit to how much credit you can take anyway. So it says to me that because you already have credit you have less credit to ask for.

MR. WOLCOTT: Something like that.

VICE CHAIRMAN BONACA: Yes. I understand that there is a precedent there so far as that, the credit. The issue raised to the Commission has been purely the one of what is the criteria for acceptability. How far can we go? And one of the concerns that we have is that there is no limit and it's left to the judgment of the applicant and the judgment of the reviewer to determine case by case whether or not they're going to grant it. That's not a way to deal with what pressure credit in our judgment at least.

So anyway let's proceed.

MR. WOLCOTT: I believe I'm on Slide 12.

Another specific issue that was brought up was the consideration of external events in fire risk evaluations. I think someone raised that question earlier in the meeting here.

VICE CHAIRMAN BONACA: But that's what we were asking for in the letter and the reason is that the representation that you give is for 105 percent power uprate was a quantification statement being brought up and gave an impression that, in fact, there was a a PRA analysis all including internal initiators and we said that fire induced by seismic events may be significant. Why don't you consider those?

MR. WOLCOTT: Yes, that evaluation was done by the staff and TVA doesn't have a Browns Ferry fire PRA. So those -- The way we've gone about it, the utility has gone about quantifying risk or -- I shouldn't have said the word "quantifying," characterizing risk and looking at the amount of margin we have is by a deterministic analysis. That's the way we chose to do it and in that analysis we're assuming that the fire occurs in each area. So it kind of sets aside the need to try to figure out what caused the fire. We're assuming a fire occurs in each area and deal with it, show how we would deal with it.

So the risk analysis that was discussed in our February 1, 2007 meeting was a result of the staff's risk analysis. And they can address that further, but that's kind of how --

That's everything that we've come prepared to talk about having to do with Appendix R. So I'll just summarize Appendix R and then we'll move onto one more issue that was not an Appendix R issue.

For the Appendix R event, what we see and I think we've made these points, that our licensing basis analysis does comply with Appendix R and it demonstrates a successful shutdown path.

VICE CHAIRMAN BONACA: If you obtain the credit you're asking for.

MR. WOLCOTT: Yes. I mean, it

demonstrates a path. We may not be able to use it if we don't obtain the credit. But it does -- We feel like it demonstrates the path and I think our concern -- your concern with it is the amount of margin.

We think we've shown that the magnitude and duration of containment overpressure that shows up in the licensing basis analysis is driven by Appendix R rule based assumptions and not necessarily what you'd actually expect to occur and that we have a fire hazards analysis. When you use a fire hazards analysis specific to the plant it shows a reduced or no dependency on containment overpressure depending on what area of the plant you're talking about.

I will be leaving Appendix R issue at this point and picking up one additional issue and that's bias and uncertainty in the realistic LOCA analysis. Dr. Bonaca, you said a few things right at the beginning of the meeting that shed a little bit more light than what we had understood before a little bit more. So we'll try to understand what the issue is as best we can and address it.

We presented in the ACRS meeting on Unit 1 a series of analyses that demonstrated how much the result changes as we vary input assumptions from realistic assumptions to licensing basis assumptions to worst case assumptions and where those realistic analyses came from for a LOCA. This isn't for a fire now but for a LOCA. Where they came from is they were done in order to define the success paths that we would going to use to build a PRA model so that we could quantify the risk of COP for all the events except a fire and our bottom line in that, in what we submitted for our license amendment, was PRA risk numbers and these realistic analyses that we showed were made for the purposes of building that COP part of that model.

They were in and of themselves intended to be still bounding analysis. They just weren't as bounding as the licensing basis analysis. For instances, instead of using tech spec values, if we are better than that 95 percent of the time, we used our 95 percent non-exceedance value. That was an important thing, say, in river water temperature because we never have come close to what the tech spec limit is. So that makes a big difference whether we use that or we use this 95 percent value.

And in the case of when we actually started using these in the PRA model, some of these parameters like river water temperature had a probability distribution associated with them rather than a bounding value. If they had a distribution, we used the distribution and if we couldn't determine one, we used a bounding value that just might not have been as bounding as the license basis.

And we used the same analysis methods that we would have used in the licensing basis. So in that sense, we called them realistic analysis, but they were still bounding analyses. They weren't what I guess everybody else calls best estimate. So we intended them to be bounding analysis and as such that was our expectation that they give bounding results. And so from that standpoint, it was our intention to account for bias uncertainty there by biasing them to the uncertainty.

VICE CHAIRMAN BONACA: What happened -- Of course, now time has gone by, but what happened was that we received a presentation and you've made the point that the requirements for COP most likely the long-term LOCAs is caused by the expressed concern imposed the LOCA requirements and we said that makes sense. We would like to see some evaluation of that and one possibility would be a best estimate analysis done by some means, in fact, which eliminates the concern that we had earlier to the most directly your point. That's a success path.

And you came back or some engineer for you came back and gave us a presentation and I remember that that was a limited analysis that wasn't complete and not with uncertainties. So as we said, "When you come back next year, show us some" -- But the path is still there. As I understand, the BWR, all this group, has been developing, in fact, a methodology to provide for that evaluation.

MR. WOLCOTT: This is very much like what we are using here. It has a few more elements to it, added to it, but it's fundamentally like what we did here.

VICE CHAIRMAN BONACA: Can you use that?

MR. WOLCOTT: It's more of a best estimate than this is. This is more bounded.

CHAIRMAN SHACK: But here when you're using the probability distributions I assume you are doing calculations, sampling calculations, and looking at distribution results and then giving us the 95 percentile of those.

MR. WOLCOTT: Yes, but --

CHAIRMAN SHACK: I mean, it's certainly fair to use the 95 percent for some variables. It's fair to use probability distribution. But you do have to sample and come back with a --

(Off the record comments.)

And we realize it's a conservatively biased 95^{th} but it's the best you can do because you don't understand all the variables.

MR. WOLCOTT: For the long-term LOCA in the end or in our actual submittals, the conclusion that the need for containment overpressure in a LOCA is driven by licensing basis assumptions. It hinges strictly on single failure. If we eliminate a particular single failure in the RHR system, we don't need containment overpressure and that's by a bounding licensing basis analysis because if it got too large --

MEMBER BANERJEE: What's the single failure you would have to eliminate?

MR. WOLCOTT: There are a number of them. There's one that you worry about that gets us down to one RHR pump.

MEMBER CORRADINI: Which one is that? A battery failure.

MR. WOLCOTT: Yes, it's a battery failure. That's logic on one side.

MEMBER BANERJEE: Logic or the battery actually?

MR. WOLCOTT: It's a battery failure, but it affects RHR because it affects logic. That, of course, takes no credit from getting around that by just operating the thing by hand for which we would never take credit for in the licensing basis analysis. So it's a battery failure because you have to -- logic power and several different things.

MEMBER BANERJEE: And you couldn't guard against that in some way, some redundancy?

MR. WOLCOTT: That's a LOCA now.

MEMBER CORRADINI: Yes, I was just going to say. That's a LOCA. That's not an Appendix R.

MR. WOLCOTT: It's a random thing.

And the other thing, it's also we have to remember -- I don't have the LOCA curve for you here. But in the LOCA analysis the only pump that needs containment overpressure is the core spray pump. The RHR pumps do not need it.

VICE CHAIRMAN BONACA: Yes.

MR. WOLCOTT: And the way we're doing our licensing basis, we default to use the core spray long term to cool the core and the RHR pump to cool the suppression pool, but you don't have to do it that way. But that's our licensing basis. That's what we stick to.

CHAIRMAN SHACK: I want to go back to the owner's group now. It's one thing to go and use the distribution of values and then look at the best estimate calculation. It's another thing to do it with single failures. We're in a different universe again.

MR. WOLCOTT: I understand. But that's -- But my point was the way it turns -- I think the same thing was true for Vermont Yankee that there is one particular single failure that drives the LOCA to need containment overpressure and that's using bounding licensing basis analyses so there's not a lot to figure out there. You either assume that or you don't. That's kind of what we boiled it down to.

And all these other things were much more complicated but were really meant -- were really done and presented to show how we built the PRA.

VICE CHAIRMAN BONACA: Let me ask the question then. Will at some point in the future you bring up an analysis like this, a bounding analysis, without the conservative to show that you got a fair COP or the requirement for COP is driven by the conservatism of a LOCA? I haven't seen this realistic LOCA.

MR. WOLCOTT: We submitted the analysis that shows that.

VICE CHAIRMAN BONACA: When?

MR. WOLCOTT: August of 2006, I believe it's in there, that shows that if you don't have one single failure you don't need COP if that's what you're saying.

CHAIRMAN SHACK: Are you going to give us an analysis with single failures but using these assumptions to show that if you can't do without COP you can greatly reduce the amount?

VICE CHAIRMAN BONACA: Yes. We don't want to have a different analysis. Otherwise, we want to have the same analysis if you take -- that the requirements for COP is driven by the conservatism with the LOCA model which means it has to be the same assumptions of single failure LOCA which would simply realizes some of the conservatisms if not all of them and that would support your claim and we can look at the results of it.

CHAIRMAN SHACK: Or you can submit the same failure one, too? We can look at that. But this one I think you need to submit also because again I think most of the discussions have not been prone to the single failure but have been doing best estimate calculations like the way we do LOCA in a design basis best estimate where there is still single failure but you've done the thermal hydraulics under a best estimate or a conservatively biased best estimate.

MR. WOLCOTT: I believe we can lay that out several different ways.

VICE CHAIRMAN BONACA: Are there any additional questions? I think this was a fruitful meeting. I think that there was communication and I think we have some paths laid out. I think you understand what our concerns are and maybe we need to get more dipping into the report that we got from your vendor. I think you have some assignments there, too. And I think that I don't know what the process is going to be. This is an informal meeting and we have no commitment your information before the subcommittee meeting scheduled for November. But we will caucus and let you know.

MR. WOLCOTT: We really appreciate your time and appreciate the feedback. It was good communication. I did try to capture notes. I understand there are a lot of concern over the Sulzer pump report, a lot of questions. I captured those and I guess most importantly is how that relates to the licensing basis and potential uncertainties in the margin. We will be prepared to address those things when we come back to the subcommittee meeting.

VICE CHAIRMAN BONACA: Okay.

MEMBER MAYNARD: Mario, while it's important to hear from the Licensee, I think an important aspect for our next meeting for when the licensing actually comes is going to be what the staff says and I'm sure they've been listening and they understand. It's going to be important to hear what their basis for acceptance is if they're recommending this up.

VICE CHAIRMAN BONACA: And we will see some kind of draft SER on this issue but it's not really different from what we have before it. They have to understand that. I think they are working, the staff, to develop this kind of criterion that we mentioned to the Commission we should have and -- agreed to. So they are not going to review it and then take the licensee through different hoops. If the staff approves, then we --

MR. ROLAND (phonetic): Bill Roland, Division Director of DSS. Mario, you talked about different criteria.

VICE CHAIRMAN BONACA: Yes.

MR. ROLAND: As you know, the Commission had an opportunity after the ACRS meeting to ask the staff to evaluate or pose different criteria and the

Commission declined that opportunity. Basically, the Commission as a result of the ACRS committee meeting told the staff to continue to try to adjust these issues with the ACRS, with the Committee, and where appropriate or we deem appropriate we would send a Commission paper to get these issues resolved once and for all and that's based on our judgment. So as we go through this whole process, that's one thing we've considered.

VICE CHAIRMAN BONACA: Okay.

MR. ROLAND: And as you might know, we have almost done a white paper, a new kind of white paper, that DSS has prepared on containment overpressure that provides really a lot of background on this whole issue. So when it's appropriate, we're going to share that with the Committee.

VICE CHAIRMAN BONACA: Thank you. With that, I would like to turn this to you, Mr. Chairman.

CHAIRMAN SHACK: Okay. Time to break for lunch. We will return at 2:15 p.m. Off the record.

(Whereupon, at 1:06 p.m., the above-entitled matter recessed to reconvene at 2:15 p.m. the same day.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Toby Walter
Official Reporter
Neal R. Gross & Co., Inc.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Status of Resolution of GI-199

Marty Stutzke, Division of Risk Analysis
Jon Ake, Division of Engineering
Office of Nuclear Regulatory Research

July 10, 2008

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U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Issue Summary

- The staff has identified that the estimated seismic hazard levels at some current CEUS operating sites might be higher than seismic hazard values used in design and previous evaluations.
  - Review of updates to seismic source and ground motion models provided by ESP applicants.
  - Review of recent USGS seismic hazard estimates.
  - Comparison to seismic hazard estimates developed under the IPEEE program.

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Background

- Concern identified May 2005 in a memo from NRR to RES.
  - NRR concluded that the seismic designs of operating plants in CEUS still provided an adequate level of protection.
- GI-199, "Implications Of Updated Probabilistic Seismic Hazard Estimates In Central And Eastern United States On Existing Plants," was opened in June 2005.
- In February 2008, a screening panel concluded that GI-199 should proceed to the safety and risk assessment phase.
- Public meeting held on February 6, 2008.
- NRC and EPRI are finalizing an MOU to share seismic research information.

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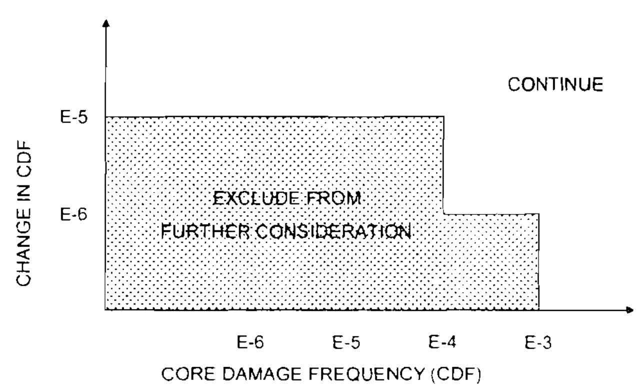
MD 6.4 Screening Criteria



6

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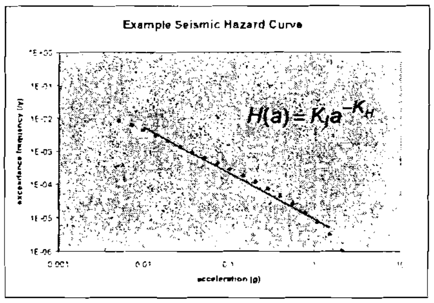
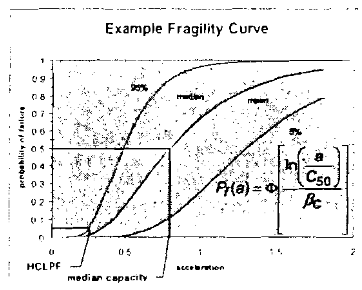
Approximate SCDF





$$SCDF = \int_0^{\infty} H(a) \left[\frac{dP_f(a)}{da} \right] da = K_I \exp\left[-K_H \ln(C_{50}) + \frac{1}{2} K_H^2 \beta_C^2 \right]$$

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Path Forward

- Complete the safety/risk assessment
- Hold public meeting on safety/risk assessment stage progress
- Convene the Safety/Risk Assessment Panel
- Draft memo and report for Safety/Risk Assessment Panel

10

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT

POWER UPRATE
ACRS

CONTAINMENT OVERPRESSURE
(COP)

Rockville, Maryland
July 10, 2008

Introduction

- COP Part of BFN Current Licensing Basis for Appendix R and LOCA

- EPU Results in Additional COP need in Licensing Basis Analysis

- ACRS Concerns from Unit 1 105% Review
  - Magnitude and duration of Appendix R event
  - Feasibility of protecting second RHR pump
  - Consider external initiators when using risk-informed arguments for the Appendix R COP credit
  - Realistic long-term LOCA analysis needs to be supported by more defensible sensitivity analyses

Introduction

- Actions Taken to Address ACRS Concerns on Appendix R COP
  - July 2007 meeting with NRC Staff
  - Fire area analysis undertaken to compare COP needs for realistic fire versus Appendix R analysis
  - Deterministic analysis to provide risk insight
    - Submitted November 15, 2007
  - Followed-up with NPSH analysis for limiting cases
    - Submitted June 12, 2008

Alternate Fire Shutdown Analysis

- Appendix R Rule Based Fire
  - Prescribed Appendix R fire damage
    - Loss of all equipment not meeting generic separation criteria
    - Fire damage not based on analysis
  - Fire damage overly conservative for many areas of the plant

Alternate Fire Shutdown Analysis

- Fire Hazards Analysis
  - Supplement to Appendix R
  - Fire damage by analysis versus prescribed fire damage
  - Screen based on fire protection parameters
    - Combustible loading
    - Volume of fire area
    - Detection/Suppression
    - Ignition sources
  - 22/39 fire areas screened out
    - Fire limited to ignition source
    - No wide spread fire damage
  - 17 fire areas screen in
    - Evaluated for equipment availability

Alternate Fire Shutdown Analysis

- Equipment Availability Analysis
  - All equipment in fire area assumed lost in 17 fire areas
  - Unaffected equipment used per EOIs
  - Offsite power credited where unaffected
    - BOP systems available in many areas
  - 15/17 areas do not need COP
    - Sufficient equipment available to limit pool temperature
  - Only 2 fire areas need some COP
    - Electrical Board Rooms

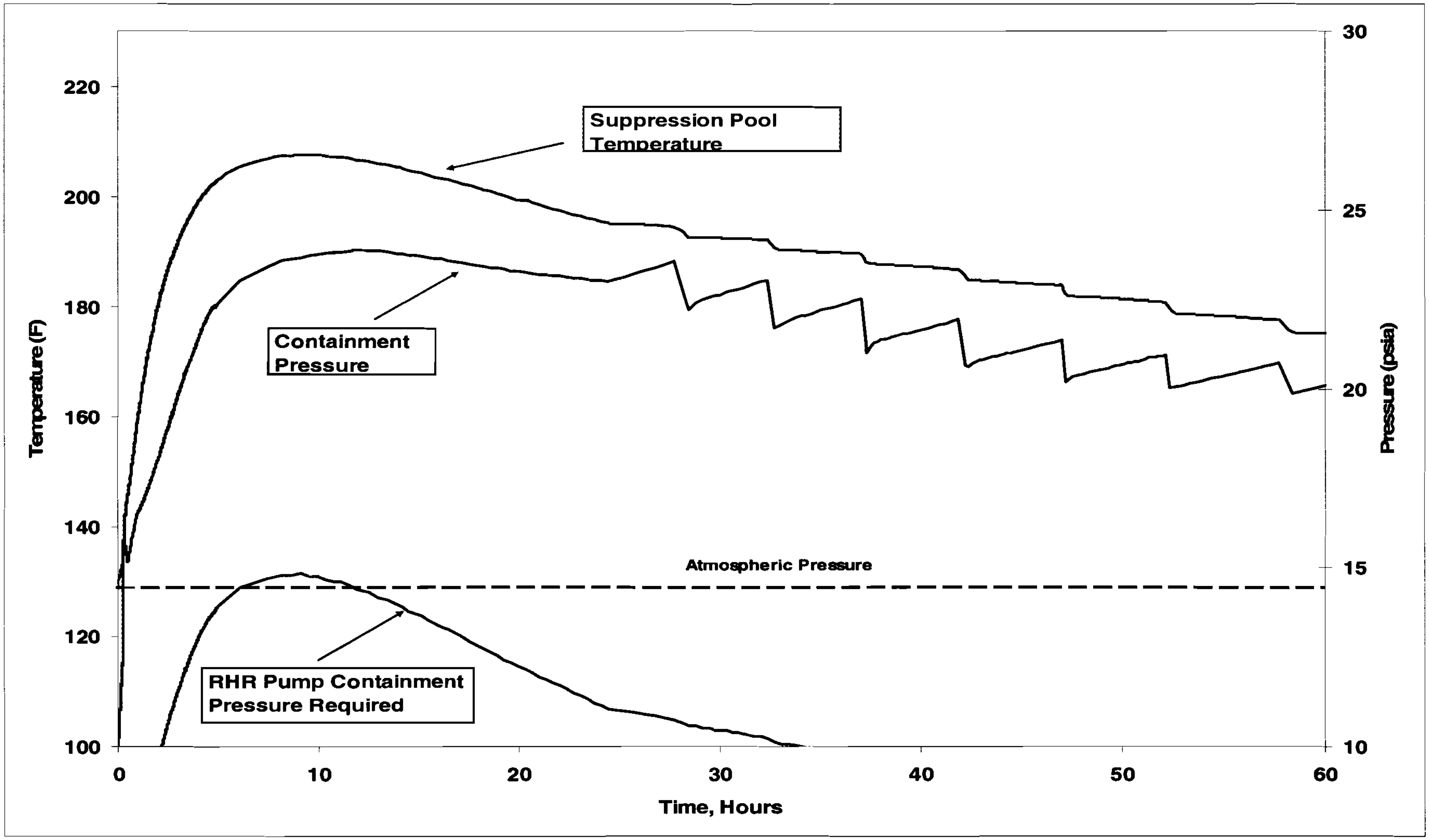
Alternate Fire Shutdown Analysis

- NPSH Analysis – Limiting Fire Areas
  - Minimum equipment
    - Emergency depressurization
    - Reactor water level maintained with BOP
    - One RHR pump for containment cooling
  - Pool water volume increased during event
    - Peak pool temperature lower
    - Pool level/elevation head increase
  - Relaxed NPSHr based on revised vendor report
    - Based on shorter operating time consideration
  - Termination of drywell coolers not required

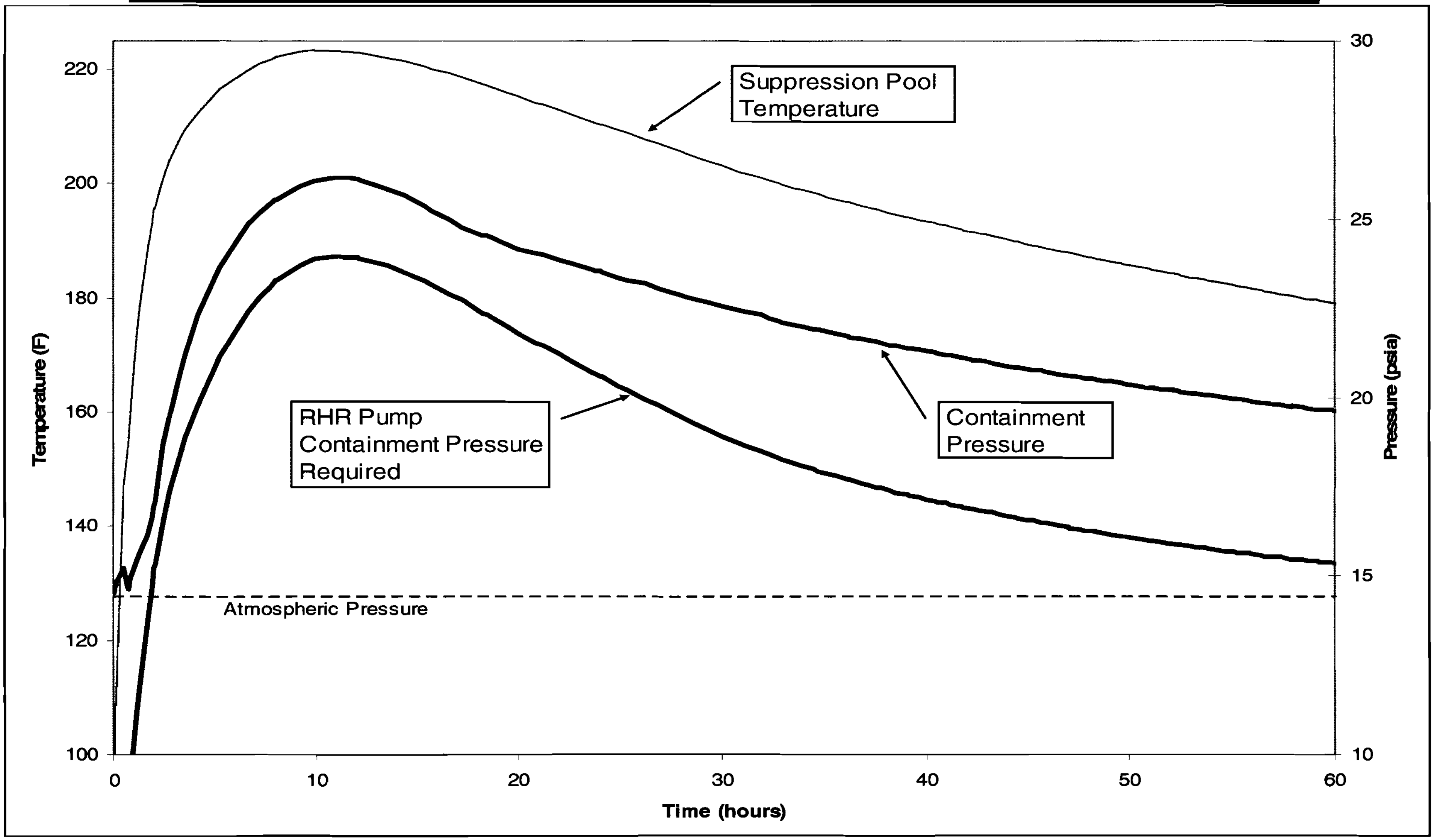
Alternate Fire Shutdown Analysis

- NPSH RESULTS
  - Significant reduction in COP required
    - ½ psi COP
    - 6 hour duration
  - Significant COP margin
    - Minimum 8 psi
  - Core cooling not dependent on COP
    - Core cooling by BOP Systems
    - Defense-In-Depth consideration

COP Available and COP Required
Alternate Fire Hazards Analysis



COP Available and COP Required Licensing Basis Appendix R



Specific ACRS Recommendations

- Feasibility of Second RHR Pump for Appendix R
  - Extensive resources
    - Physical location of switchgear
    - Shared electrical system
    - Support equipment
      - Valves/controls
      - Diesel generator/controls
      - RHRSW pump/valves
    - Significant modifications
    - Significant program and licensing changes
  - Minimal safety benefit
    - Demonstrated by fire hazards analysis

Specific ACRS Recommendations

- Consideration of External Events in Fire Risk Evaluations
  - Fire risk insights from deterministic fire hazards analysis
    - Not a PRA analysis
    - Bounding fire is assumed

Appendix R Conclusions

- Licensing Basis Analysis Complies With Appendix R and Demonstrates a Success Path
- COP Magnitude and Duration for Appendix R Driven by Rule Based Assumptions
- Fire Hazards Analysis Shows Reduced or No Dependency on COP

Additional ACRS Issue

- Bias and Uncertainty in Realistic LOCA
  - Realistic LOCA used to build PRA model for COP
  - Use of 95% non-exceedance values
  - Use of probability distributions
  - Use of conservative licensing basis methods
  - Realistic NPSH analyses biased conservatively

Closing

- Concluding Remarks

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Seismic Research Program 2008-2011

ACRS Meeting
July 2008

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Program Overview

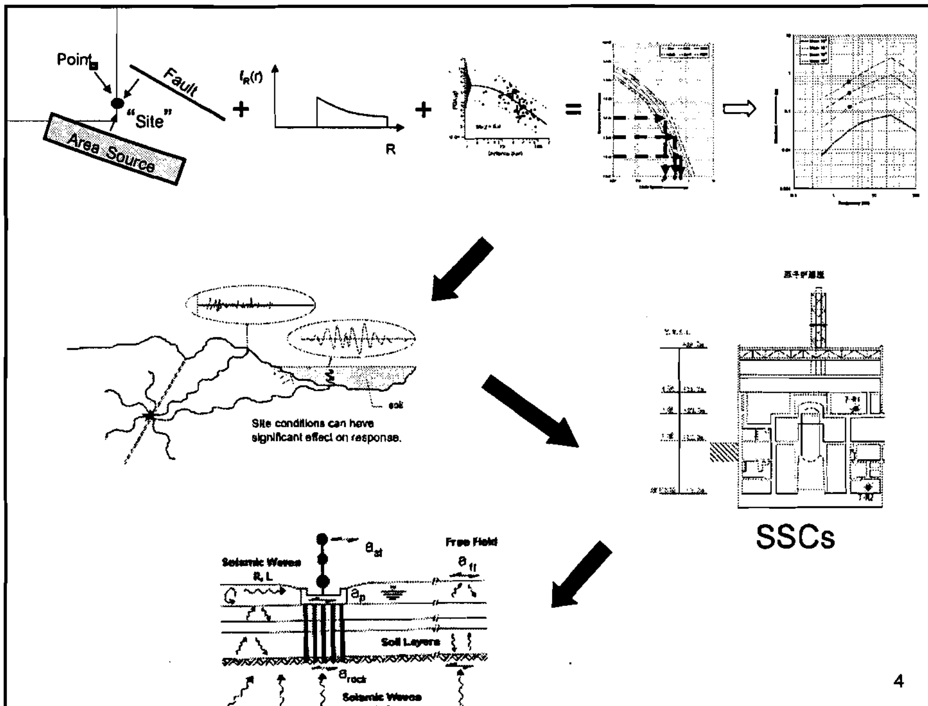
- Pu blicly available research plan
- T argeted on regulatory needs
  - Developed with NRO, NRR & NMSS
  - Efforts in many research areas to be coordinated with industry
- De veloped to both push forward the science and the level of regulatory stability
- In corporation of performance-based approaches

2

Program Philosophy

- Short- and long-term research topics
- Systematic & integrated
  - Moves from topic-by-topic approach to integrated research
  - Focused on issues with highest uncertainties
  - Risk informed plan that fills in gaps
- Cost effective
  - Piggy backing and partnering
  - Universities
  - Using “next-generation” approaches
- Highest Quality

3



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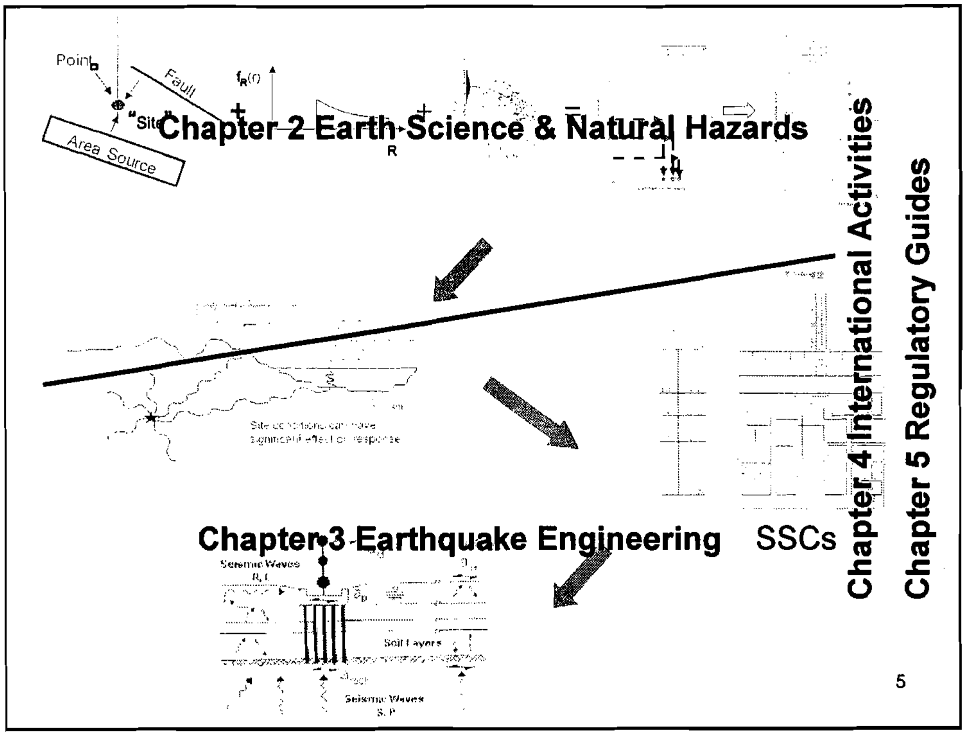
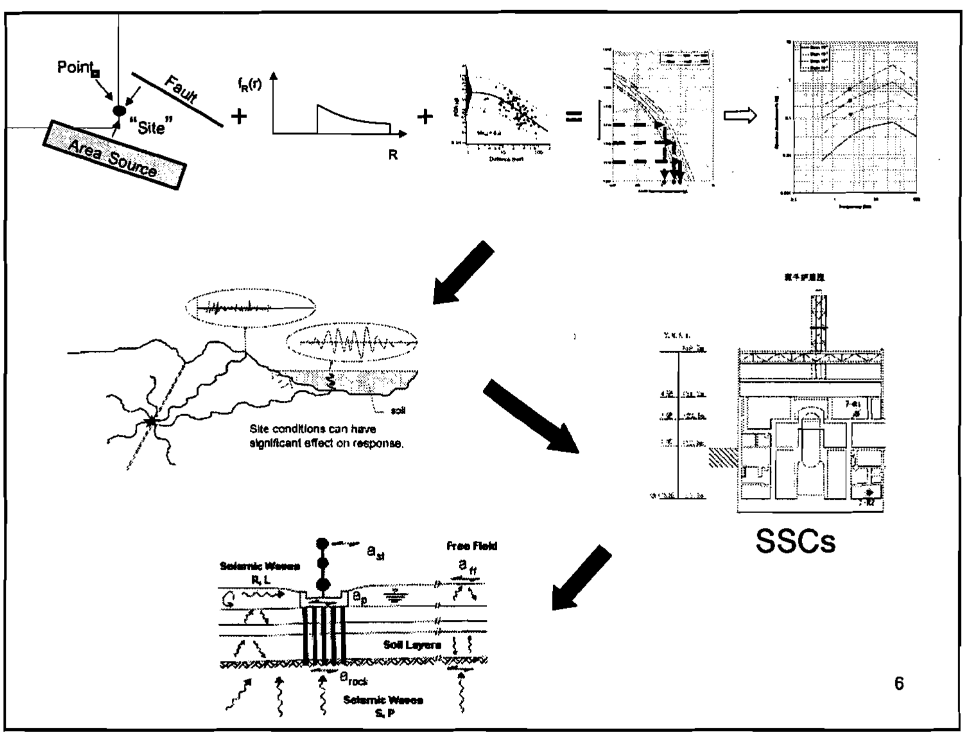
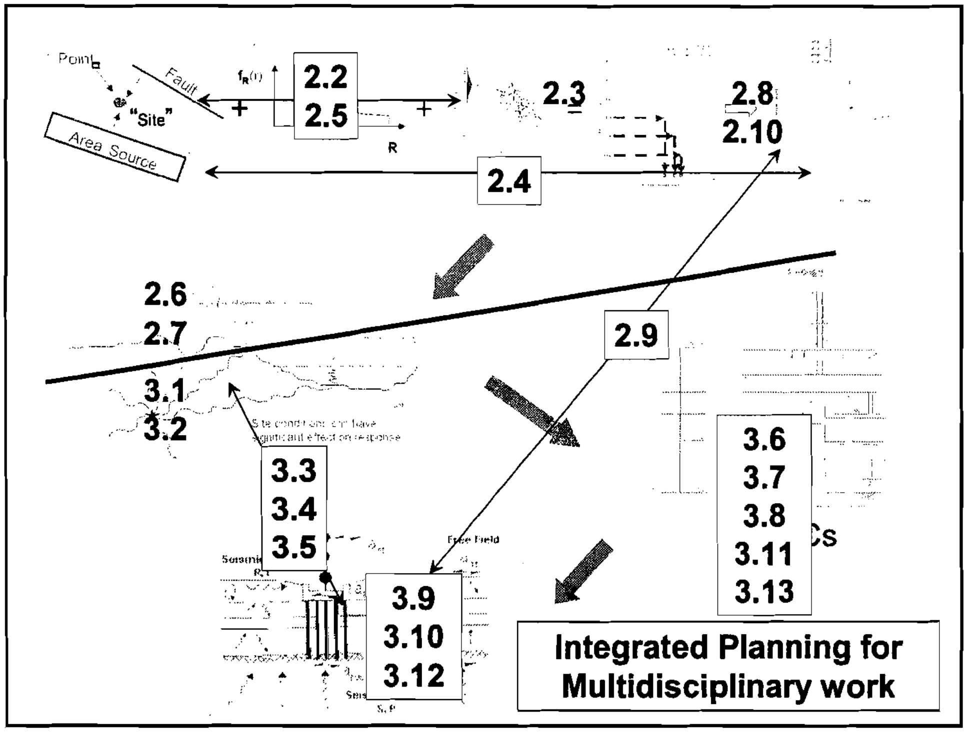
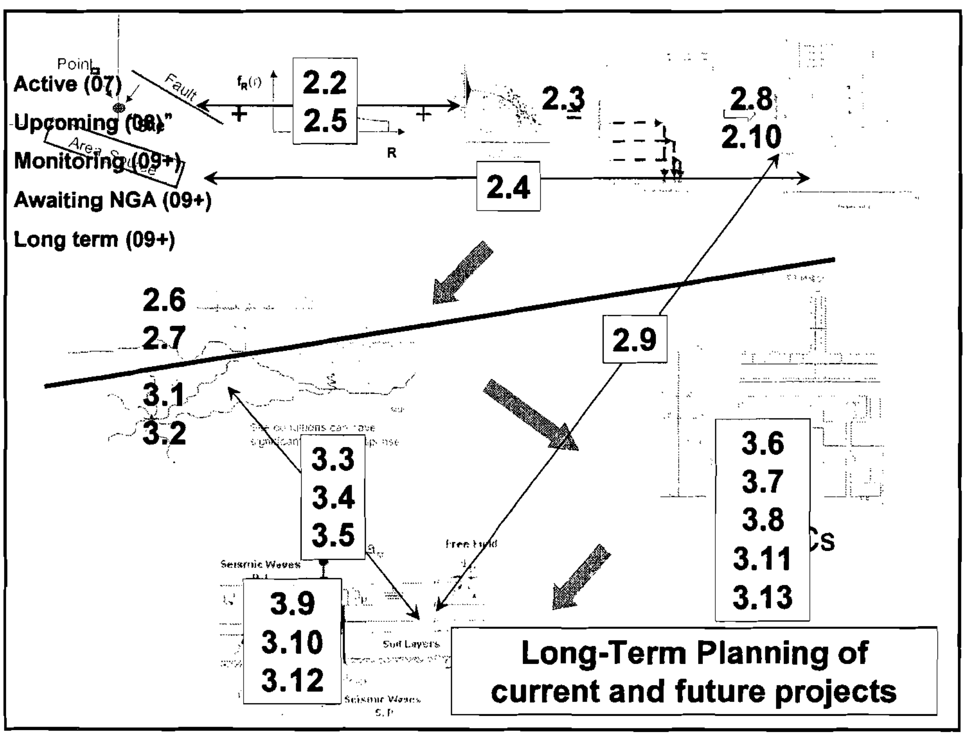

Point
Fault
"Site"
Area Source
R
Chapter 2 Earth Science & Natural Hazards
Chapter 3 Earthquake Engineering
SSCs
Chapter 4 International Activities
Chapter 5 Regulatory Guides
5


Point
Fault
"Site"
Area Source
$f_R(r)$
R
Site conditions can have significant effect on response.
soil
SSCs
Seismic Waves R, L
Free Field
Soil Layers
Seismic Waves S, P
6


Point
Fault
"Site"
Area Source
2.2
2.5
R
2.3
2.8
2.10
2.4
2.6
2.7
2.9
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.11
3.13
3.9
3.10
3.12
Free Field
Integrated Planning for Multidisciplinary work


Active (07)
Upcoming (08)
Monitoring (09+)
Awaiting NGA (09+)
Long term (09+)
2.2
2.5
R
2.3
2.8
2.10
2.4
2.6
2.7
2.9
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.11
3.13
3.9
3.10
3.12
Seismic Waves
Soil Layers
Long-Term Planning of current and future projects

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Workshops and "Next Generation" approaches

- NRC initiated early seismic hazard work
- Seismic research moving from the development of individual tools and methods
  - Different databases, gray literature, proprietary reports, proprietary software
- The now mature field is moving to integration through workshops, working groups and "next generation" approaches
  - Common databases & inputs, community consensus, documentation of thought processes, outliers & uncertainties better understood

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Workshops and "Next Generation" approaches

- Consistent, complete, and agreed upon data sets and information
- Key experts in the research area involved
- "Next Generation" implies fundamental redevelopment of technical tools or approaches
- Both best estimates & estimates of uncertainties

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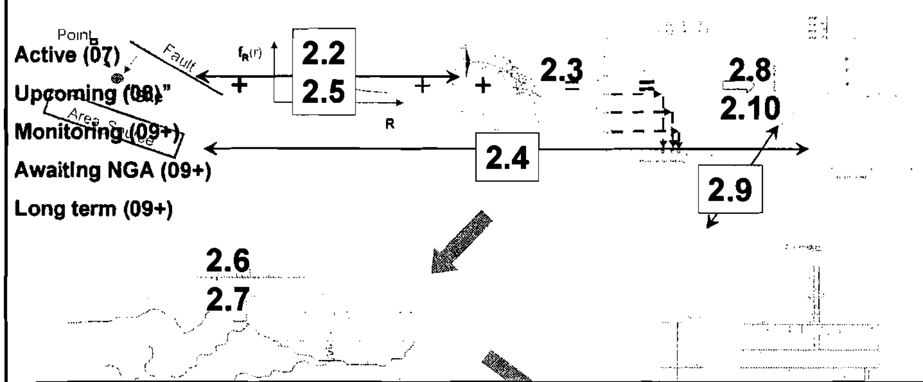

2.2	Mmax ('07)
	CEUS SSC Project (08)
	Sensitivity & uncertainty study to address issues and prioritize research needs ('08)
2.3	Next Generation Attenuation (NGA-East) ('07)
2.4	Application of SSHAC Guidelines ('07)

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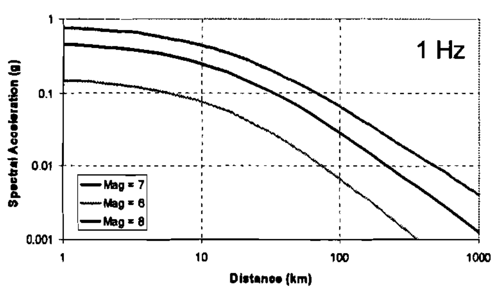
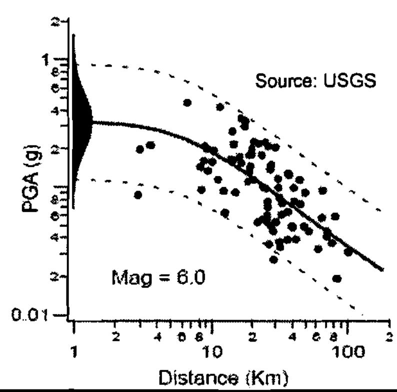
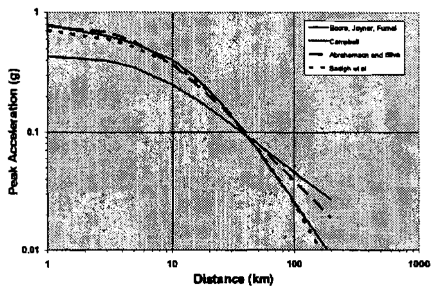
Seismic Wave Amplitudes vs. Distance

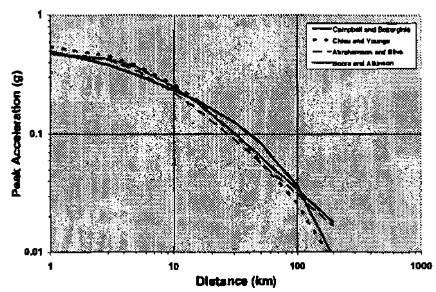




NGA-East

Before NGA-West **After**





- Went from ad hoc relationship development to unified approach
- Mutually agreed upon databases, technical bases & assumptions
- Epistemic uncertainties reduced and characterized
- Broad community consensus (removed points of contention)

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NGA-East

- Follows up on original NGA project to address
- Approach
  - Standard agreed upon assumptions
  - Standard and complete database
  - Development program undertaken to scope project and bring in multiple agencies
  - Cooperative agreement with multiple agencies (DOE, NEHRP, EPRI)
  - USGS in-kind participation in development project
- Currently doing preliminary work
  - Technical Basis for assumptions
  - Development of earthquake record database

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SSHAC Guidelines

- "Recommendations for PSHA: Guidance on Uncertainty and Use of Experts" NUREG/CR-6372 by Senior Seismic Hazard Analysis Committee
- General framework work well, but limited details
- Need recommendations on how to use and to update
- Much has been learned in trying to apply SSHAC
  - Yucca Mountain (two level 4s – seismic and volcano)
  - PEGASOS (level 4)

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SSHAC Guidelines

- New project created to develop practical recommendations for application of the SSHAC guidelines
  - Lessons learned
  - How and when to update
  - Understanding and characterizing uncertainties (epistemic and aleatory)
- Will develop a NUREG document to accompany the SSHAC guidelines

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CEUS Seismic Source Characterization project for Nuclear Facilities

- Major study with participation from NRC, DOE, EPRI, USGS, and other US specialists
- NRC SSHAC guidelines level-3 study
- 3 year project starting summer 2008
- Project to develop a seismic source database for the CEUS to be used as a baseline for all PSHA
- NPP applications will still study local sources
- Coordinating a CEUS SSC "International Observers Program" to allow international specialists to observe the US project firsthand

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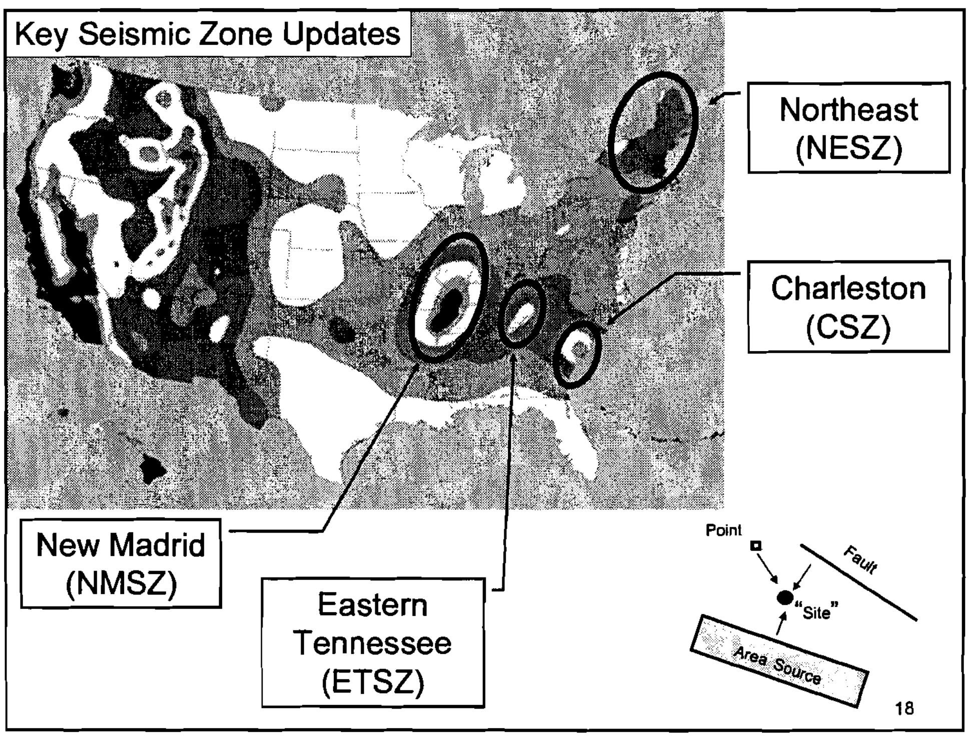
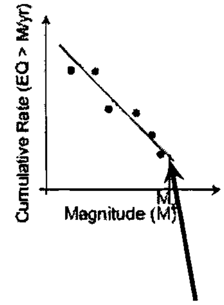


M_{max} Workshop



- M_{max} is largest magnitude for a source
- Issue for area sources in CEUS for long return periods
- Limited technical basis due to lack of systematic, integrated evaluation of existing models and new data
- Follows "best practices" for seismic workshops
  - Sensitivity study
  - Foundation document compiled & sent to participants before workshop for review. Also downloadable at USGS.
  - All key researchers sponsored, but open to anyone
- Results incorporated into USGS database

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New US NRC Projects to Assess Seismic Hazard in CEUS

Source Characterization →	Central and Eastern US Seismic Source Characterization project for Nuclear Facilities (CEUS SSC)
Ground motion prediction equations →	Next Generation Attenuation Relationships for the Central and Eastern (NGA-East)
Framework for large PSHA studies →	Recommendations for Application of the SSHAC Guidelines

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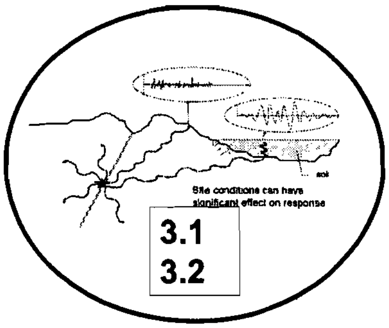
3.1 Random Vibration Theory
3.2 Site response methods



Active Projects

- Multiple methods accepted in NUREG 6728
  - Theoretical framework but few details
  - Only recently used
  - Implementation differs between practitioners
  - Focus on better understanding
- Multiple modeling tools currently in use
  - Non-linear, SHAKE, and RVT methods
  - Comparison of methods
  - Developing public RVT software with PEER

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Site SSE (GRMS) compared to CSDRS

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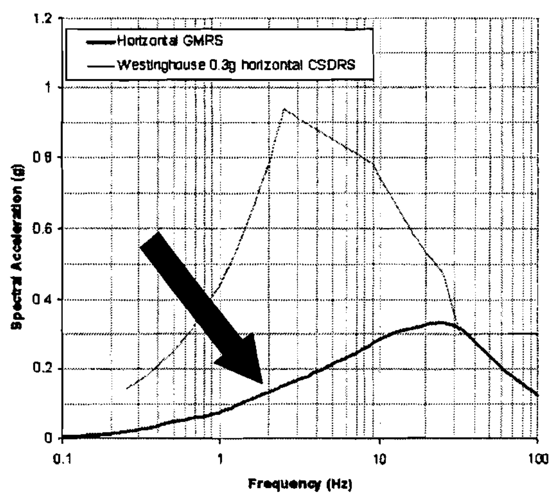
GRMS is based on site characterization and it is determined from detailed seismic hazard studies

CSDRS is based on engineering design of a plant



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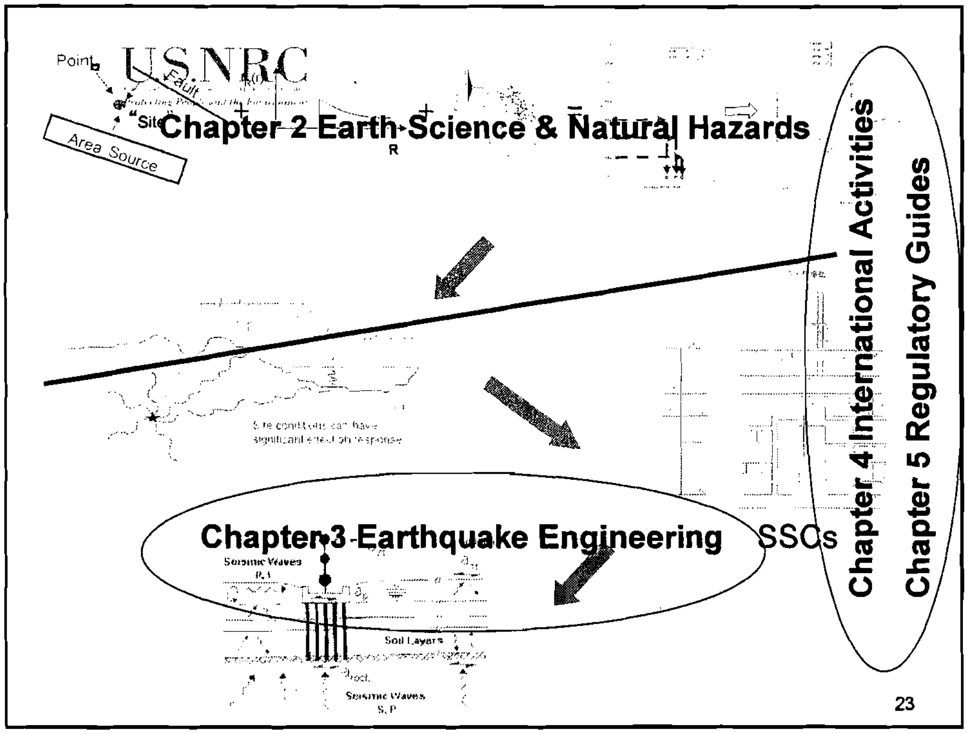

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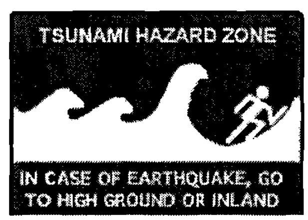

Tsunami

- Continued tsunami source development with USGS
  - Phase 1 report being used by NRC staff and industry
  - Phase 2 underway
- Continued development of modeling capabilities with USGS and NOAA

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Summary

- Seismic Research Plan publicly available
- Key drivers are both the advancement of state of practice AND greater regulatory stability
- New projects focused on seismic hazard in CEUS
- Integrated risk-informed approach
- Both short- and long-term planning
- Focus on consensus products
  - Community-wide consensus
  - Multiple stakeholders & sponsors

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Impact of the Niigataken Chuetsu-oki Earthquake to the Kashiwazaki Nuclear Power Plant

Yong Li
Senior Geophysicist
NRO/DSER/RGS2
July 10, 2008

Agenda

- Niigataken Chuetsu-oki Earthquake and Kashiwazaki-Kariwa (KK) nuclear power plant
- Impact of the earthquake vibration to the Nuclear Power Plant (NPP)
- Major findings from post-earthquake activities at the plant site

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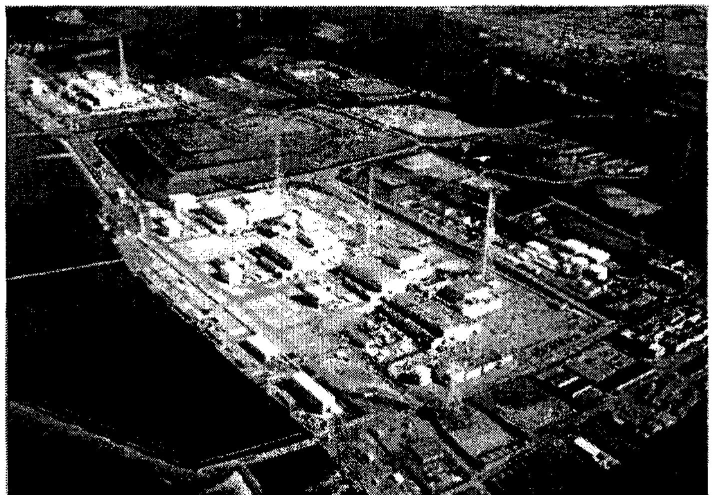
A Bird's View of KK Site from South



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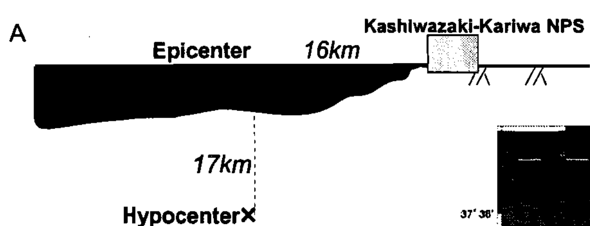
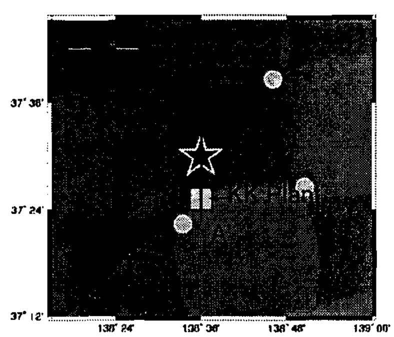
Earthquake Location relative to KK plant





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Design Peak Ground Acceleration vs. Observed (gal – cm/sec^2)

Unit	North - South direction (design / measured)	East - West direction (design / measured)	Vertical direction (design / measured)
1	274 / 311	273 / 680	235 / 408
2	167 / 304	167 / 606	235 / 282
3	192 / 308	193 / 384	235 / 311
4	193 / 310	194 / 492	235 / 337
5	249 / 277	254 / 442	235 / 205
6	263 / 271	263 / 322	235 / 488
7	263 / 267	263 / 356	235 / 355
Divide gal by 1000 to approximate g-value			

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Common Cause Failures and Potential Vulnerabilities

- Settlement and soil failures
  - ✓ Breakages of underground fire protection piping joints
  - ✓ Deformations and cracks in the ducts connected to the main stacks
  - ✓ Deformations and fire on the Unit 3 house transformer secondary bus

- Potential for adverse interaction with safety related equipment
  - ✓ Water leakage through building penetrations
  - ✓ Water leakage through leaky seals
  - ✓ Damage to thermal insulator of SLC piping

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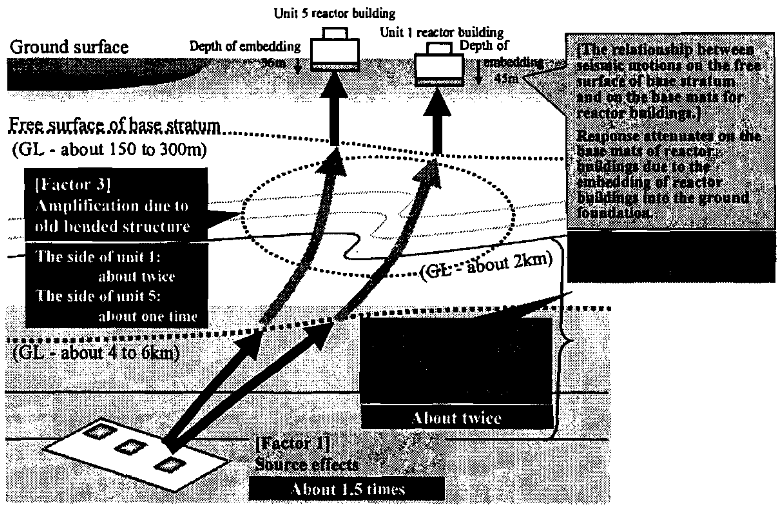
Factors to Amplify Seismic Motions



From TEPCO 6/12/2008 presentation

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Ongoing Activities at the KK Plant

- Non-destructive testing for hidden damages
- Assessment of new ground motion for reevaluation of the plant safety
- Evaluation of the plant design upgrading

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Interim Staff Guidance on Seismic Issues associated with High Frequency Ground Motion

Dr. Manas Chakravorty
Structural Engineering Branch 2
July 10, 2008

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Background

- Updated ground motion models for earthquakes in the CEUS.
- ESP reviews identified that site-specific ground motion may not be enveloped by certified design response spectra for some sites

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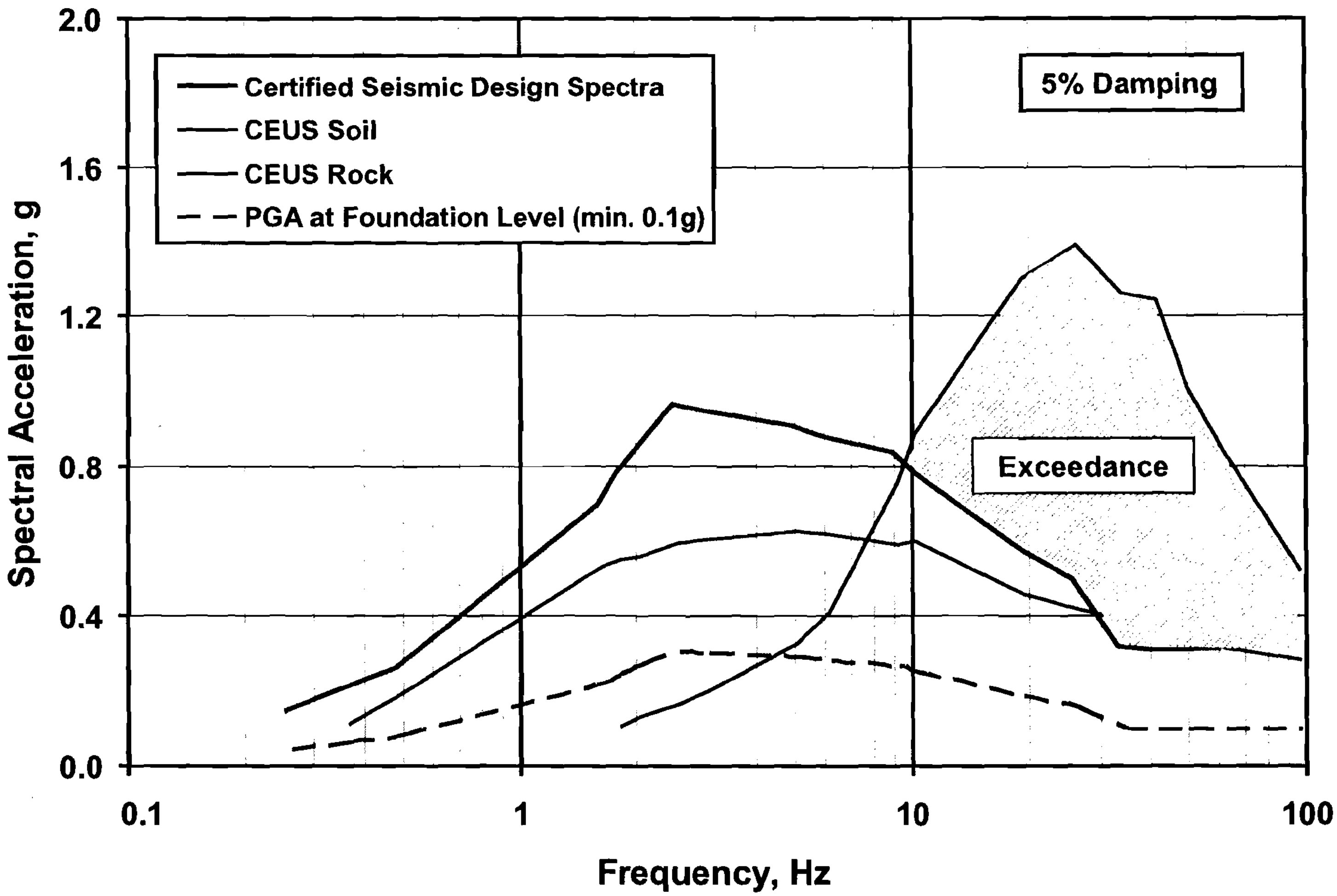
CSDRS & GMRS COMPARISON



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Resolution

- The updated SRP Section 3.7.1 " Seismic Design Parameters" provided the framework
- Issued ISG for the implementation of the SRP framework

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Issues addressed in the ISG

- Definitions of various ground motions
- Guidance on the use of the different ground motions and seismic instrumentation
- Staff position on the use of limited dynamic testing data

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Issues addressed in the ISG

- Guidance on evaluation of HF exceedance
  - Inclusion of incoherency in structural seismic response analysis
  - Screening of HF sensitive SSC's
  - Evaluation of screened components

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Summary

- SRP 3.7 & ISG provides a high frequency review framework
- AP1000 Topical report has been submitted and currently under staff review
- ESBWR has used CSDRS that envelop both soil and rock sites