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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON GESSAR II AND
RELIABILITY AND PROBABILISTIC ASSESSMENT

- - -

Belmont Room
Airport Park Hotel
600 Prairie Avenue
Inglewood, California

Thursday, February 14, 1985

The meeting of the subcommittee on GESSAR II and Reliability and Probabilistic Assessment was convened, in open session, at the hour of 8:30 a.m.

PRESENT FOR THE ACRS:

D. OKRENT, Chairman
J. EBERSOLE
H. ETHERINGTON
C. SIESS
D. WARD
M. BOHN, Consultant
R. SAVIO, ACRS Staff

NRC STAFF PRESENT:

D. SCALETTI
M. RUBIN

ALSO PRESENT:

K. SHIU
N. CHOKSHI
R. BARI
J. REED
R. HARDIN
B. IBRAHIM

PRESENT FOR G.E.:

K. HOLTZCLAW
D. HANKINS
D. FOREMAN
J. QUIRK
R. VILLA

P R O C E E D I N G S

8:35 a.m.

CHAIRMAN OKRENT: The meeting will now come to order. This is a combined meeting of the Advisory Committee on Reactor Safeguards Subcommittees on GESSAR II and Reliability and Probabilistic Assessment.

I am David Okrent, Chairman of the Subcommittee. The other ACRS members present today are Mr. Ebersole, Mr. Etherington, Mr. Siess, Mr. Ward. Also present is ACRS consultant, Mr. Bohn; Mr. Savio, raising his hand, is the ACRS Staff member for this meeting.

The purpose of this meeting will be to continue to review the application of the General Electric Company for a final design approval that can be applied to future plans referencing the GESSAR II concept the BWR/6 Mark III Nuclear Island.

This will be the third in a current series of subcommittee meetings to review the General Electric Standard Safety Analysis Report to extend the final design approval so that it will be applicable to future plans.

The principal topic of discussion at this subcommittee meeting will be seismic risk evaluation.

Portions of the meeting may be closed due to the proprietary nature of some of the material covered. I ask General Electric to alert me to those portions of the meeting which they believe will involve proprietary materials.

A transcript of the meeting is being kept and it is requested that each speaker first identify himself or herself and speak with sufficient clarity and volume so that he or she can be readily heard.

We have not received any requests to make oral statements nor have we received any written comments from members of the public.

First, let me note that it is planned for the meeting to run to some quitting time today but that, tomorrow, I expect we will adjourn no later than noon so that, if we seem to be running more slowly than the agenda estimated today, I expect to run a little late today.

Let me, if I may, start the meeting with a few thoughts and questions and these are partly for the subcommittee to think on and partly for the NRC and General Electric to think on.

If one looks at the SFER number 3, that the staff issued and, if one looks at the reports prepared for the staff by their consultants in the seismic part of the review, one sees that there are quite a few technical questions which are not being resolved at this time and that, in one way or another, the staff is proposing that what you might call a more thorough seismic review be done in connection with any construction permit application that references the GESSAR II to FDA.

A reasonably large part of the GESSAR II plant itself would have to be looked at in connection with such a new seismic PRA, since there are these technical questions and, also, it is not clear, at the moment, whether the approach that would be taken at an actual plant, the seismic hazard, for example, including uncertainties, et cetera, would correspond enough to what GE has done that one could just take what GE has done. There are questions about the fragilities General Electric has used and so forth, as well as some of the methodology.

So, it seems to me, one of the questions that the ACRS has to think about is: What does it mean if we agree to the issuance of an FDA under these circumstances and are we satisfied with issuance of an FDA under the approach that the staff outlines in their SFER-3?

Then, it seems to me, that there is a second kind of question. In the absence of what I will define as a seismic PRA which the staff accepts, including the entire plant but, also, dealing with all aspects of the portions of the plant covered by the FDA, how does one decide that GESSAR II is adequate in what it proposes to do in the areas which it covers? More specifically, how does one decide that its shutdown heat removal is adequate if one has not fully analyzed shutdown heat removal for seismic? How does one decide that the measures proposed for containment are adequate if there is not a full evaluation of seismic? How does one decide that the evaluation of possible improvements, which GE did in its study, in terms of the PRA it presented, how does one decide that those will be valid when one has a more thorough seismic PRA?

How does one know that they will, in fact, not, in a sense, leave one in a, let's say, possibly, unhappy sort of awkward position in certain aspects where he wished he had something different, but accepted the FDA, after he looks at what is supposed to be the PRA for the actual plant? In fact, how does one know that the seemingly negative cross-benefit results on various features won't look differently, given what I will call a staff-accepted PRA with the full treatment of uncertainties, et cetera, plus some engineering detriments, in view of the uncertainties of the bounds.

In fact, if we just think of the containment aspect, we do not, at the moment, have containment performance criteria by the staff. Hence, we have no measure, in a sense, of when a containment is performing adequately, including the seismic part.

It is conceivable that new bypass paths will arise out of a more thorough seismic PRA. I don't know.

But, with no containment performance to measure overall behavior, where will one stand and so forth?

So I, for one, at the moment, do not find myself in a good position to just move and agree with the approach that the staff seems to be proposing in this regard. I am interested in learning more in this area to see why and if what is being proposed makes sense or, in fact, whether it does make sense to issue an FDA under these conditions.

Anyway, I wonder if the subcommittee members have any comments in this sort of basic kind of issue as distinct from the specific technical issue that we will get into, of course.

MR. EBERSOLE: Dave, I would like to make a comment. I am a little bothered by what, I guess, I call the methodology of approaching this seismic problem. I just came from a rather intense meeting on fire protection in Wilkes-Barre (phonetic), which is a Westinghouse plant and here is my problem.

I see, in here, a lot of shots, fragilities, on pieces of equipment but I don't see a coordinated plan that says, "What do I need to shut down to get the shutdown heat removal process to work?" "What are the detailed elements of the plant that I need, down to the last gear and cotter key?" "Don't give me generalities, I want to know where the pieces are."

And then I want to know that they will work and then I want to know that, beyond those pieces, what pieces which I don't need but which might fail in some disorderly way will inhibit the functions of the organized set that I need for shutdown. And then, having identified this, along the lines of a Q-list, display these individually and grind to a conclusion what the fragilities are, what the margins of competence are to do their jobs, what the margins to failure are under seismic influence.

Instead of that, what I see is a succession of shots in the dark at a variety of things like valves-at-large, hangers-at-large, et cetera, et cetera. I think that the GESSAR II is intended to be delineated in such sharp detail that we can close on it and cease to worry about the generalized aspects of its competence because we know the detailed aspects of it. I hope that is going to be the case. It may be I am overly optimistic.

There is another thing. There is expressed in here a continued dependence on complex chains of systems on which you are dependent to get the heat out, as a case in point. GE has, as its capacity to do so, a highly simplified way of doing this which diminish the target size for seismic influence. If we are not confident, in the end, that these complex and interdependent chains of equipment will work under these queer challenges which we can never, of course, put our thumb right tight on. I think it is important to invoke such simplifications as are possible in this unique design which so different from the PWR's.

CHAIRMAN OKRENT: Any other comments?

Mr. Siess?

MR. SIESS: I think this is general, Dave.

In the Brookhaven report, reviewing the GESSAR PRA, there are frequent references to something not being conservative. Now, I do not find the same kind of language in the SER but I do find it in the Brookhaven report.

And it is not clear to me whether it really means not being conservative or not being correct. I thought PRA's were supposed to be done on a best-estimate basis and not using conservative-type licensing of functions.

I do not know if anybody can address that or not. The staff does not use that language but the Brookhaven does.

CHAIRMAN OKRENT: I will ask the staff to reflect on your comment and, at an appropriate time, respond to it.

Any other substantive comments now?

(No response.)

CHAIRMAN OKRENT: All right. In that case, we will move into the next agenda item in which the NRC staff is to give an introduction of assessments and a summary of conclusion.

Who is the spokesman for the staff?

MR. SCALETTI: Good morning.

My name is Dino Scaletti. I am with the U.S. Nuclear Regulatory Commission, Division of Licensing. I am the project manager for the staff for GESSAR II.

With me today I have Mr. Mark Rubin from the Division of Safety Technology, Mr. Ibrahim formerly from the Defense Originary (phonetic), Mr. Robert Bari from Brookhaven National Laboratories, Mr. Calvin Shiu from Brookhaven National Laboratories, Mr. Hardin from the Division of Safety Integration from the NRC staff, Louis Chokshi from the Division of Engineering and, also, Mr. John Reed from Benkem (phonetic) and Associates.

Just briefly, well, firstly, the staff will be requesting that, under item 4 this afternoon, parts B and C, be closed because they do discuss General Electric propietary information. Up until that time, we have nothing that would be of propietary nature, in order to close the meeting.

I will, briefly, fill you in on the status of the unsolved safety issues and the conservatory issues indentified in supplement 3 to the GESSAR II Safety

Evaluation Report. The containment construction analysis has been one portion which is demonstration of compliance to the CPML rule is complete and will be reported in supplement 4.

The dry well analysis and containment failure modes is still undergoing discussion but, I also believe, that will be completed and also reported in supplement 4.

The staff has completed the evaluation of they hydrogen control measures that were under discussion previously, a combination of compliance with the new hydrogen rule of 75 percent metal/water reaction and a combination of the plant protection system to comply with the hundred percent required by the CPML rule.

The potential design modifications, the staff, at the request of the ACRS, has met with and will meet again with IDA and General Electric to discuss the differences between the constant benefits tnat were developed by GE and by IDA.

The safety parameter display system, again, is still under review. We have identified our concerns to General Electric in the form of draft safety evaluation report which, I believe, you people have. They have responded to a couple of the concerns. We are still talking about those. I plan to publish the majority of their evaluation of the safety parameter display system in supplement 4.

The USI's and GSI's that remain outstanding, again, are still being reviewed and, hopefully, they will be resolved by supplement 4.

The external events which are under discussion today have three outstanding issues identified, the relay chatter, consequence analysis and full bypass.

From the standpoint of relay chatter, the staff has identified or has talked to GE and identified concerns we have with regard to relay chatter. I guess three possible options to resolve this issue for GESSAR II, one of them would be for GE to complete an analysis that we would request, and give it to us before the review is complete. Another alternative would be a final design approval condition requiring it be done prior to issuing a construction permit or prior to filing an application for a construction permit by a utility applicant or as an interface issue which would be, then, left -- the burden would be placed upon the utility applicant to resolve it to the staff's satisfaction prior to issuing a construction permit.

The confirmatory issues are identified, are the ones that are remaining, are identified in supplement 3.

The sliding issues, the staff will report on that at supplement 4. The other issues, the station blackout, shutdown decay heat removal, will be resolved in conjunction with completion of final design of the UPPS. The combustible gas control is still under review and it may be a while before it is resolved.

The optical isolators required the staff to visit San Jose -- excuse me, the software engineering manual required the staff to visit San Jose and I see no plans in the immideiate future to do that to resolve that conservatory issue.

The optical isolators may be resolved in supplement 4.

The interfaces information has been identified, the additional interface information, in table 2 of the SER, supplement 3. This table is not all-inclusive. The interface information identified both the other two supplements and, also, in the SER. All this information will be reviewed again, at the time an application is filed, that references GESSAR II. And, at that time, the subcommittee and the ACRS will have an opportunity to rereview this information or to review it for the first time.

CHAIRMAN OKRENT: All right. May I ask a question?

MR. SCALETTI: Surely.

CHAIRMAN OKRENT: You were sent a copy of the comments prepared by our consultants at Sandia with regard to, I guess, what one would call internal events for the PRA and there was interest in some additional information.

Has that been prepared or where does that stand? Could you remind me?

MR. SCALETTI: Dr. Savio and I talked about that the other day and I was unaware of a request for us to comment or to respond to additional information in the ACRS's consultant report.

When I get back to the office, I will, again, talk to Dr. Savio and see what can be resolved in that.

CHAIRMAN OKRENT: Well, I am sorry you misunderstood. I thought it was clear that we were interested in having our consultants get the information that they were interested in. In mean, I don't know why we would get them as consultants if we did not try to see that they can get information in the same way that you have your consultants get information.

What is the problem?

MR. SCALETTI: The request to the staff, Dr. Okrent, as far as I know now, and Dr. Savio can correct me if I am wrong, was: Could the ACRS consultants confront freely with the Brookhaven consultants over the telephone and the staff felt it would be better if -- certainly, we did not object to them conferring with Brookhaven, at all, however, we did want to be aware of what was going on.

All effort should be made, whenever a conversation of this nature took place, that one staff personnel was there to understand the resolution of the problems or what the problems were. And, to my knowledge, no attempt has been made.

CHAIRMAN OKRENT: Mr. Savio?

MR. SAVIO: It is my understanding that Sandia has had some conversations with Brookhaven regarding, not necessarily their report, they are getting some additional information.

Is that correct?

MR. BOHN: I don't know. I do know that, right now, they are short on information. They feel they need to evaluate the parts that they are studying right now.

CHAIRMAN OKRENT: Well, let me advise the staff that we will want to be sure that our Sandia consultants have that information that they consider to be significant. So, I will leave it at that for now.

Go ahead.

MR. SCALETTI: I believe that completes all that I have to say with regard to issue number A under item 2. Mr. Rubin, now, will --

CHAIRMAN OKRENT: Excuse me. You just mentioned the schedule of the SFER?

MR. SCALETTI: Oh, I am sorry.

Presently, the schedule would call for another supplement 4 to be issued in March.

CHAIRMAN OKRENT: Beginning or end?

MR. SCALETTI: I wish I could be that definite.

CHAIRMAN OKRENT: All right.

MR. SCALETTI: Probably the middle or towards the end.

CHAIRMAN OKRENT: Thank you.

MR. SCALETTI: Mr. Rubin will discuss the bypass sequences.

MR. RUBIN: The seismic evaluation is not complete in the areas of the back end water. The consequence analysis still remains to be done. And, as part of that, two full bypass sequences are still being considered by the staff and our consultants, Brookhaven National Laboratories.

Preliminary results indicate that there were two additional bypass sequences that were not considered in the General Electric seismic risk assessments. The two sequences identified involve a massive structural failure involving reactor pressure vessel, the drywall containment and the shield buildings as one sequence and, also, a possible bypass sequence involving the RHR heat exchanger.

Both of these would involve potential loss of the suppression pool and the release of unscrubbed material following a core melt.

As indicated, the work is not complete. Preliminarily, it appears that the massive structural failure is quite unlikely but consequences are being considered by the staff and we will be reporting that in a supplement.

The RHR heat exchanger failure is still under evaluation and we are not yet confident on quantification of the sequence that is being worked on currently.

Wfhen we complete this work, we will report it to you.

MR. EBERSOLE: Could you tell me a little bit more about the RHR bypass being in the heat exchangers?

MR. RUBIN: Yes, the RHR bypass sequence involves the failure to the heat exchanger, most probably the support rupture of the heat exchanger shelf tubes, the draining of the suppression pool, potentially, below the level where you get effective scrubbing of the fission products. And the increased consequences would be beyond what was originally anticipated and analyzed before in those releases.

MR. EBERSOLE: So, you bypass the suppression pool through loss of water, through the heat exchangers?

MR. RUBIN: Yes, into the RHR heat exchanger rooms and possibly for right now, outside the rooms.

MR. EBERSOLE: And then you subject the containment, then, to an unsuppressed pressurized --

MR. RUBIN: That would also --

MR. EBERSOLE: What I am trying to get at: They have got this space where the containment site is itself, more than it ceases to hold fission products, it also contributes to making the accident worse?

You were taling to post-core melt phenomenon, aren't you?

MR. RUBIN: Yes.

MR. EBERSOLE: You are not taling about bypass in the context of a bypass initiating the event that caused the core melt?

MR. RUBIN: That is correct. It was not initiation event.

MR. EBERSOLE: Right.

The reason I asked, it is important all containments carry a penalty. If you don't get the heat out, they can, then, lead to core damage.

Then the GE design has the, as a feature, however, has scrubbing and it would be, at least in my view, to select a second bypass because of core melt without the privilege of opening the secondary side of the suppression system.

Now, I really don't know what is in place now, in the logic, once you get a bypass, but you still have an undamaged core. Whether we vigorously permit discharge from the back side of the suppression pools or not to prevent core damage, is there any generic practice in that respect?

MR. RUBIN: There is protection against, say, failure of the heat exchanger into the rooms and for unmitigated loss of fluid from the system. You have room alarms; you have procedures for terminating, isolation valves --

MR. EBERSOLE: It is -- involve a --

MR. RUBIN: Yes.

MR. EBERSOLE: I see.

Well, the effect which I said -- core damage, would, then, containment failure occur and you would inherit core damage from that?

MR. RUBIN: Just a moment.

MR. EBERSOLE: The reason I ask that, I don't think that should be the case.

MR. SHIU: Calvin Shiu from Brookhaven.

The statement that we have looked at involves only of the core damage. The possibility of failure is that, should there be a tragic event, the heat exchanger failed and, as a result of its failure, leading to a potential drainage of the suppression pools.

MR. EBERSOLE: But, up to this point, there is no core damage?

MR. SHIU: Up to this pcint, there is no core damage.

MR. EBERSOLE: All right.

MR. SHIU: And, in the meantime, if an assumption is made, because I have lost by -- heat exchanger, that there would be no containment heat removal capability and, eventually, there will be core damage.

MR. EBERSOLE: But they are still have to use a loss of special process, but you haven't damaged the core?

MR. SHIU: Right.

MR. EBERSOLE: There is the privilege you have with this plant, I guess, with a degree of suppression to relieve the containment on the back side and, thus, prevent it from causing core damage.

MR. SHIU: There is possibility with their avenues, given you have lost your RHR heat exchanger, to continue to maintain some sort of venting and keep --

MR. EBERSOLE: I am inviting --

MR. SHIU: The UPPS system, for instance, would mitigate this particular scenario.

MR. EBERSOLE: If it were designed to cope with it.

MR. SHIU: That is right.

MR. EBERSOLE: Which it is not now.

MR. SHIU: We have not examined that particular --

MR. EBERSOLE: No, it is designed as an -- perspective of recovering the loss of power, I believe.

MR. SHIU: Well, I believe that, if we assume that UPPS will survive the initiating event, the earthquake, that, potentially, it can be considered.

MR. EBERSOLE: This was the point I was getting around to. Have you exhausted your avenues of escape?

MR. SHIU: In the BNL (phonetic) evaluation, we did not include a UPPS as part of the consideration.

MR. EBERSOLE: Thank you.

MR. SCALETTI: Dr. Chokshi will address the seismic monitorings from the standpoint of the staff.

MR. CHOKSHI: This is a detailed presentation planned this afternoon on the fragility aspects and there are a lot of fragility issues that will be discussed during the presentation.

This morning, I am just going to briefly summarize what is the oral stop findings (phonetic), and comments from the GESSAR PRA review as it addresses the margin issue.

One thing that most specific seismic margin study comes of which has been characterized as a high-probability consequence of failure. That nature (phonetic) was conducted for the -- by staff and I am, also, not aware of what -- has done but --

CHAIRMAN OKRENT: I am sorry. I can't hear. Would you speak a little more slowly, please.

MR. CHOKSHI: The staff did not conduct a specific margin study in terms of high-probability, low -- high-confidence, low-probability -- values of 95 percent confidence, five percent failure. It was presented in limited meeting.

The reasons for that this study is almost precluded by the very nature of GESSAR II that it not an active plant or actual site and the details are not available to conduct that kind of study in any meaningful fashion.

As we will discuss this afternoon, there are -- aspects which help -- and site specific -- and are not addressing -- generates the other.

Manual fragilities are based on segment and from the previous CRA's and which will, also, require a detailed evaluation and as to a particular site to assess some margins.

So, in terms of high-confidence, low-probability of failure, that kind of margins we do not have in quantative sums. However, based on PRA review and both FDA review, we have some feelings for the margins in general and I would like to briefly say what we think of.

Structures and component levels, I think it is already strong feeling that for structures whose capacity is governed by seismitic environment, and I am excluding in these the structural capacity based on the soil in negative failure modes, those stuctures, I think, in looking at the GESSAR fragility values, although we have some doubts and some questions about it, I am enthused that -- it is still believed that those values indicate that those structures have a high capacity as you would expect from an element of design.

For confidence and for site -- aspect, we do not have enough information at this time to conclude -- For an example, SLC tank, the fragility and -- are limited value without regard to the location of that particular component in the building -- for consideration.

Looking at actual plans, the fragilities are quite different. A lot of -- for Limerick. However, on the structure of designs, also, are more complete and I think there is more confidence the structures exhibit margins of similar -- plans. And I will cite an example where the capacity will go on structure design will be a shield building where the shields and structurals are primarily -- from seismitic consideration and you will see tl at these have more capacity than for a plant-specific dεsign.

CHAIRMAN OKRENT: Excuse me. If I understood correctly, all of these points are going to be covered in more detail?

MR. CHOKSHI: Yes.

Yes, these plans just give brief summary of what we think about margin at this time.

I wanted to point out that the GESSAR II design is done to the current stock requirement and it contains the conventional conservatism such as -- drills versus the -- drills, the radioconductor analysis, response combination which are very similar to the --

And additional margin comes and these come as applicable back to, again, structural capacity, is from developing design department. So, at some sites with lower SSE, you will see some margin -- in design for those components.

However, I would like to conclude on this particular topic that all this needs to be demonstrated in a more detailed fashion, on a plant-specific basis, to really evaluate margins in more quantative terms, particularly with components and site-specific aspects which I want to discuss in the next few minutes, which I need some more -- by way of information.

You are aware of the fact that margin panel is looking at some -- PRA's to come up with generic, high-confidence, low-probability values and I believe that that is going to be presented to you the next few weeks.

CHAIRMAN OKRENT: Excuse me. I am not quite sure what the interpretation is of the remark that you made that there needs to be more evaluation of margins.

When? By whom and so forth? Could you help me on that?

MR. CHOKSHI: Yes, I think we have indicated that on site-specific basis, the needs to demonstrate that the fragilities are -- to those that are found in GESSAR or equivalent to what was assumed in the staff analysis, sensitivity analysis.

The condition, too, at the --

CHAIRMAN OKRENT: I am not quite sure what you mean when you say assumed in a sensitivity analysis.

Usually, in a sensitivity analysis, one takes a variation in things. What does it mean to say, "...the same as assumed in a sensivity analysis"?

MR. CHOKSHI: The BNL conducted the studies of alternate fragility of the components which were not included in GESSAR, to get an idea of the margins of --

CHAIRMAN OKRENT: But what --

MR. CHOKSHI: Those fragilities were based on the past PRA's.

CHAIRMAN OKRENT: But what does it mean to say, ..."the same as the staff assumed in its fragility analyses"? I am trying to understand the sentence, at the moment.

MR. CHOKSHI: Those are representative of fragilities in the sense that those represent, in past PRA's of -- plants.

CHAIRMAN OKRENT: It is vague. You are answering a different question.

MR. RUBIN: Dr. Okrent, staff and our consultancy now felt that the critical components list was not complete for the plant and proposed what they thought were likely representative fragility values for missing components, structures.

As a starting point, we have presented those in a requantification as part of the sensitivity analysis to come up what we feel are better values for seismic contribution to core melt. And, when an application is made referencing GESSAR, the site is selected, the full scope of the plant is available, we feel that the fragilities have to be reassessed and they should be compared to the value that has been postulated in our evaluation where deviations are identified, a more complete risk assessment needs to be conducted to determine whether the fragility values in the as-built plant will be sufficient.

CHAIRMAN OKRENT: Now, presumably, you specified some value with an uncertainty distribution around it or --

MR. RUBIN: That is correct. Well, yes, the table in the SER and the BNL report indicates the beta values around the component structural facilities.

CHAIRMAN OKRENT: And when General Electric compares something with that, they are also comparing some kind of subjective estimate with some subjective estimate of an uncertainty distribution or what?

MR. CHOKSHI: I would make a general comment and then ask Dr. John Villa some comment on this.

At this point, I would think that when the fragility analysis is being carried out, the assumptions and some of the values would be very similar to what we have seen in past PRA's or, at least based on some kind of judgment which we can -- look at the -- on those values and to the process similar to which is being carried out for their PRA's in computing total distribution.

CHAIRMAN OKRENT: By the way, I want to make an observation here. It is true that we have a family, now, of seismic PRA's but there is a commonality in the estimation of fragility. And there could easily be a common mode error here. I think it is somewhat dangerous to assume that having three or four PRA's gives you much additional information. And I don't know how to factor that in but I can look back in history and think of times when there was one person who took one point of view against the rest of the scientific community and won out. So, one has to be a little cautious.

Here, you don't even have what I would consider to be the benefit of many different independent experts. A second thing is, what you find acceptable for existing plants in the PRA's may or may not be what should be acceptable for a new FDA. It is not clear to me that the same standards should be used, for example, with regard to knowledge of fragility. It is not clear to me at all.

In fact, I would like the staff to think on this question. I am not looking for an off-the-top-of-head answer. This is just: What do you think should be acceptable in regard to this kind of uncertainty in our knowledge as well as other aspects of the plant that have similar questions or a new plant, for a new FDA.

Now, you may come back and say the same. I want to know why the same, if that is your position.

MR. CHOKSHI: If the actual mechanics of that, the intent of that requirement has to be, as you say, to part out and monitor.

CHAIRMAN OKRENT: Well, we are trying to raise broader considerations today, since this is our first attempt to go through an FDA or a standard plant approval under what may be the Commission policy.

All right. Go ahead.

MR. CHOKSHI: If there are no more questions on the margin issue then, I would like to talk about the next item, about how the fragility analysis encompass various site conditions.

CHAIRMAN OKRENT: All right. Before you do that, you, sort of, left out liquifaction.

MR. CHOKSHI: I am going to address it.

CHAIRMAN OKRENT: You are going to address it?

MR. CHOKSHI: Yes.

CHAIRMAN OKRENT: All right.

MR. CHOKSHI: Again, I am going to, similar to my previous comment, is going to be very brief and just a summary of what will be discussed in considerable details this afternoon.

But, I am going to highlight -- value. We think there are -- fragility analysis compared with all sites. Most often, BNL review identified sole structures and compnents and failure modes which are quite dependent and have not been considered in GNR's explicitly at this time.

For example, of structures and components not included in GESSAR II fragility evaluation are some of the things that are found on the other PRA's such as retaining walls and -- piping.

Of course, these are outside the scope of GESSAR II design, Nuclear Island, and these are the DOP-type of structures.

But, before I go into more detail, I would like to mention that, for the deterministic design review, GESSAR did design plans for plant 2G (phonetic) with various site conditions, ranging from a relatively soft site to a rough site. And many parameters which include the -- such as imbedment will, also, consider the parameters established from the deterministic design point of view to address various sites.

The same -- or same degree of -- is not in the PRA calculations. PRA calculations are more general and, therefore, I think it is not clear to us that they are bounding (phonetic) when you consider various sites or conditions.

Going back to the failure modes, and such which you have not -- not have an exclusive address of the liquifaction and settlement and slope failure, for an example.

The deterministic design addresses this issue of the relative levels. However, the SSC (phonetic) -- I think this issue, they have to be dealt on site-specific basis.

CHAIRMAN OKRENT: How?

MR. CHOKSHI: What was the question?

CHAIRMAN OKRENT: How?

MR. CHOKSHI: How they should be dealt on the site-specific basis?

CHAIRMAN OKRENT: Yes.

MR. CHOKSHI: I would, again, point to the PRA's done on other plants which held this phenomena.

For example, on the -- is currently looking at this deception potential which might -- that issue has been based -- that they should look at the liquifaction but that the index structure is not -- but --

CHAIRMAN OKRENT: What criteria will you use in judging whether or not something is acceptable with regard to liquifaction, if they meet the standard review plan?

MR. CHOKSHI: I don't have a specific answer to this question. I would think that a lot of system consideration will go into that, deciding whether liquifaction is that extent which leads to a certain kind of unacceptable consequences.

I don't have any specific --

CHAIRMAN OKRENT: I must confess that is not a very well-defined approach for how one would deal with the issue at the site-specific review and I suspect, if I ask a similar question concerning components and structures as to how you will judge adequacy, if they meet the SRP, it is going to be a similar answer and it sort of leaves me not knowing quite where this all is.

MR. CHOKSHI: Maybe I don't understand your question, but --

CHAIRMAN OKRENT: Well, let's get back to liquifaction. Now, when one looks at how this has been approached for sites where it was an issue, the safety factors provided have varied considerably from plant to plant, always meeting the SRP.

Are you going to ask for a safety factor of five? Four? Well, you could say, "Put it on rock." or whatever. But it is, right now, very elusive, in my mind, what the basis is that the staff would use in judging beyond what is required in the SRP.

MR. CHOKSHI: I think I agree with you that the -- will come. They will come, for example, factors of safety are used for -- stability of structures and R-1 will build -- is a question which I don't have answers for. And I doubt if anyone can address, from the quality point of view --

MR. SIESS: But liquifaction is in a different category than slide and overturning. It is possible to select a site or to so modify the soil that liquifaction is impossible. The same is not true for sliding and I believe that a prudent licensee, a prudent applicant, in the future, would not even consider a site where he had to make an argument for a factor of safety on liquifaction. He could, probably, save three months of review time by either putting in a fill or picking a proper site. But that is not true for the other things.

CHAIRMAN OKRENT: Well, let me throw a little curve into what Mr. Siess has said in that there have been some cases where applicants have tried to do, let's say, what he said, namely to, at least, reduce the likelihood of liquifaction to small numbers but the quality of the work now becomes important, the quality of achieving what you set out to do on paper.

And I believe it is not clear, in the past, plants met the original design intent. In fact, I am sure we can find some examples.

So, I still find this an elusive area, among others.

MR. CHOKSHI: What I understand the comment, on liquifaction potential, it is, probably, possible to look at preventing this liquifaction by adopting certain measures, other than not relying on specific analysis, which is very uncertain.

I am understanding correctly the question?

CHAIRMAN OKRENT: Well, we are trying to understand, at the moment, just what it is the staff is proposing in connection with this proposed FDA, how questions of this sort are to be addressed and we are examining one specific issue, although there are others of the same type.

MR. SCALETTI: You are asking us to define our acceptance criteria for ten years down the road or five years down the road? It may change, at that time, when the site is identified and application is submitted that references GESSAR II. The siting information would have to be reviewed; it would have to be evaluated against -- the current PRA against all the interface items would have to be resolved. At this time, the staff will deal with that issue and, also, you gentlemen will have the opportunity to revisit that, based upon the current acceptance criteria.

CHAIRMAN OKRENT: Some of these gentlemen may; others will not.

MR. EBERSOLE: That really bothers me because of the open-endedness of the whole problem, which is the basis for failure of the whole process, at the moment.

MR. SCALETTI: Well, the Commission allows for the definition of scope and it does not require, at this time, a complete plan. Right now we have the 4-S GESSAR which is the most complete plant, standard plant we have had under review. We have more information here. We are trying to deal with this information as best we can but we realize there is going to be, when an application is filed, much work that has to be done.

The process will be shortened, I am sure but there will still be a great deal of review that will have to take place.

CHAIRMAN OKRENT: You mentioned criteria?

MR. SIESS: All your review for margins will be based on a PRA, then?

MR. EBERSOLE: The standard review plan calls for SSE with nominal margins. If you are looking at much larger seismic shaking, then your criterian will be only in the PRA. You will look and see on that basis; is that what I am hearing?

MR. SCALETTI: The only high class criteria are those that are specified in our standard review plan, in our regulations.

I will let Mr. Rubin address the PRA context here but we don't even have any hard facts criteria or implied margins within the probabilistic risk factor.

CHAIRMAN OKRENT: By the way, before he goes on, I should note, only last week I heard it said that the SRP are really not hardfast regulations.

MR. SCALETTI: Well, complying with the SRP is required by, or by regulations. 5034-G, I believe, requires that you can document deviations but these deviations have to be acceptable to the staff. But it is a regulation, 5034-G.

MR. RUBIN: Mr. Scaletti already mentioned most of the points. Let me just reiterate that.

We have no margin requirement in the PRA or attempt -- what to obtain a more accurate, to the extent possible, more representative assessments of the plants seismic risk. To the extent that site-specific factors might invalidate our assessment, or reassessment of the General Electric work, we feel that should be revisited when that information is available, to provide assurance at that point that the -- I don't know if this is really correct to use the word "margin" in this context, but to validate the quantification on the site-specific basis.

If the site -- the parameters identify that you might have rocking or sliding or liquifaction or other factors that would impinge on the plant response that would cause an increase in risk, core melt contribution, we think that should be identified at the time the plant is sited, appropriate action should be taken.

At this point in time, that information is not available to allow the process to go forward. And that is why we ask that it be revisited at a later date.

CHAIRMAN OKRENT: Mr. Bohn has a question.

MR. BOHN: Well, this is really more of a comment in regards to the liquifaction in general.

The relative displacement problems between buildings, and that is what these really address, these have turned up in past PRA's as being important.

One recognizes that the failures that are predicted are based on a relative displacement of, say, two inches or something, between buildings. And it is the relative displacement stresses that are causing the failure. They are not intertia stresses, at all.

I would think that one could define limits or GE could postulate limits on relative densities of sands of various sites which is the critical parameter in liquifaction, as well as water densities, and do a series of studies, very limited, simple studies, I should add, that would enable them to estimate for a given distance between foundations and given relative densities of sands, what type of potential there really was for causing pipe breakage.

And the could, in defining their GESSAR design, define relative anchorages between the two buildings or relative spacings between the two buildings as a function of potential for relative motion, such that you wouldn't get into this problem.

And, I think, they could do that with sufficient margin so that it would not be a problem in the future. I think the same sort of approach could be taken for components, as Neil (phonetic) had mentioned --

I suspect the types of components that are being used are relatively standard. We recently computed a walkdown of seven power plants that are operating in this country and, typically, we find, as others have found in the past, that it is anchorage that causes problems. And I would think that, in their design, the anchorage could be specified as part of the GESSAR design in such a fashicn that these problems would not constitute an important part of the risk due to seismic.

In general, we find, if there is reasonable anchorage, they don't contribute to seismic risk. If there is not reasonable anchorage, if there is just tack-welds or very small bolts holding, say, switch gear down, then it really doesn't matter what size they are, they do contribute to the risk. And I would think that these could be addressed in the context of a generic design such as GESSAR.

MR. CHOKSHI: I guess only one more item concerns fragility with respect to siting hazard, evolution itself. And parameters such as expected manipulations, a -- will also affect fragility. And the local site conditions will go on those parameters. So, that, also, has to be looked at along with hazard evaluation.

I think that, sort of, in conclusion, I would like to say that fragilistic design has considerable affect on conditions and, as we have discussed in cur previous SER's, we don't feel that in PRA context, that has been -- that all site conditions as to fragility statements are representative for all site conditions.

CHAIRMAN OKRENT: All right.

Why don't we take up item E and then we will have some general discussion -- or more general discussion -- or additional general discussion.

MR. EBERSOLE: Mr. Chairman, may I ask a question?

CHAIRMAN OKRENT: Surely.

MR. EBERSOLE: I have come to look on this, really, as no more than sort of a sampling of the methodology that GE intends to use for GESSAR II. It is, certainly, by no means, polished to include all those points I mentioned earlier. It is just, perhaps, a small sampling of the intent to go forward on a really detailed specific.

And, whatever we do here is not more than an approval of that process that they are going to use on a far more detailed basis.

Am I correct?

MR. SCALETTI: In part you are correct, yes. I think there is a lot more effort that has to take place when a site is chosen.

MR. EBERSOLE: Therefore, we need not really look, as I questioned, the fact that this is -- we are closing on this in high detail, which we are not by any means. We are just closing on the generalized methodology which will be used in high detail later on. Is that the way I --

MR. SCALETTI: Well, there is a lot of effort that has taken place which is valid and it can be used. We require that certain things be done at the site-specific stage and all this information will have to be reviewed and evaluated against -- to see whether it does fall within the site hazard curve, to see if everything fits in place.

And to say that everything will have to be done again, I wouldn't go quite that far. I do believe there is a great deal of effort that will have to be done.

MR. EBERSOLE: Well, you know there is only a small sampling of the horrendous detail that goes into a plant.

MR. SCALETTI: Certainly but I don't -- all of our SER's is, in most cases, it is a sampling of information, never a complete review process or all the detail that goes into the design that is written up in the SER.

CHAIRMAN OKRENT: Jesse, I would be a little hesitant to arrive at the conclusion you were suggesting, at least quite yet.

We will leave it at that for the moment.

MR. EBERSOLE: Yes, all right.

CHAIRMAN OKRENT: And we will see what develops.

MR. EBERSOLE: When you get into relay chatter where you invite some consideration to -- I think they are available, chatter-free relays, if you look for them.

And there is a related problem which came out recently in some reports that transducing equipment, operating near the setpoint of trip, which is not tested in the seismic mode, tends to, in effect, cross over the sensing point and become, in essence, a chattering transducer.

Do you follow me?

CHAIRMAN OKRENT: Why don't we hear what they are going to do to resolve relay chatter and, now, transducer chattering issues.

MR. SCALETTI: We didn't plan on trying to resolve relay chatter right now. We had indicated, earlier on, that -- I had indicated that it was a new problem. The staff has not totally identified this problem. We have discussed it with GE. We do have the three options that I had previously discussed. We are willing to entertain any questions you have. It is an outstanding issue; the staff hasn't completed its review and I don't know what we can tell you.

But, if you have some questions, we have some people here that will try to answer them for you.

CHAIRMAN OKRENT: Does the staff review now include or will it include, or does GE's analysis include what I would call a system behavior analysis in the face of postulated relay chatter?

MR. RUBIN: I think that is exactly what we would want to be looking for. The problem is fairly recently identified. We think it potentially could be serious but we are not convinced of that.

We need to obtain a full understanding of the plant, responsibly -- we don't have it at this point.

CHAIRMAN OKRENT: Is this something, again, that is left for the CP stage, in your mind, or what?

MR. RUBIN: We have alternatives on approaching it. We have identified various information that we feel we need to go forward on a full assessment of the plant response. And it is not yet determined if we will get all that information at this time or that some of it will have to be provided later.

CHAIRMAN OKRENT: Excuse me, but I think the staff wants to come into the ACRS to get the committee opinion. Where will this matter stand at that time?

Unresolved; is that what you are saying? Or you don't know?

MR. SCALETTI: It will probably be still unresolved; correct.

CHAIRMAN OKRENT: And it is okay for it to be unresolved?

MR. SCALETTI: It would have to be resolved prior to a construction permit being issued.

Again, Doctor, we have only a piece of the design. We don't have the complete design; we have a large part of it.

CHAIRMAN OKRENT: But before the final design approval, this is what I am trying to -- maybe it is a preliminary design approval.

MR. SCALETTI: Well, I don't think so. We mentioned earlier that the Commission allows for partial designs to be approved. The final design review is for partial design.

CHAIRMAN OKRENT: All right.

Are you going, again, to give a list of those parts of the design which are approved and those parts which are not?

MR. SCALETTI: Those are identified in the SER's as far as the interface items; they are identified in GESSAR in section 1.9, I believe it is. There is a great long list of items that have to be completed and this would be part of the construction permit review, is to resolve all of these interface issues.

MR. EBERSOLE: Well, Dave, that is what I was trying to say earlier. This is a final design of a small part of the plant, the final design approval, but, by no means, comprehensive.

MR. SCALETTI: Well, clearly, it is a large part of the plant. It is not just the NSSS.

MR. EBERSOLE: I guess I am just down in the component level, now, when I am talking about small percentage of parts.

CHAIRMAN OKRENT: Mr. Siess?

MR. SIESS: I got the impression that the staff said they don't know whether relay chatter is a problem; is that right?

MR. RUBIN: That is correct. It has been --

MR. SIESS: All right.

And does that mean that you expect to use GESSAR II as a basis for finding out whether relay chatter is a problem?

I mean, if it is a problem on GESSAR II, it is, probably, a problem on a lot of other plants.

Is there available either a digital computer program or an analog computer that would represent the control and protection system where you could introduce random relay chatter into it and see what it does in the way of C & N's or complications, or does somebody have to sit down with a line diagram and make a lot of assumptions?

CHAIRMAN OKRENT: I think you would want the power system in there, too.

MR. SIESS: Power system. Anything that has relays in it.

MR. RUBIN: I think we would, certainly, like to have available to us that first option and I don't believe it is available.

MR. SIESS: You mean the other alternative is to wait until the earthquake occurs and find out what happens. But that is really not the way we --

MR. RUBIN: That is not --

MR. SIESS: We have done this in the past but let's -- I thought we were trying to get away from that.

MR. RUBIN: Well, we definitely are. This is a developing problem, recently identified. I think first referenced on the Limerick PRA as a potential impacting --

MR. SIESS: What, relay chatter?

MR. RUBIN: Recently, on Limerick.

MR. SIESS: How recent? It has been around for at least three years that I know about.

CHAIRMAN OKRENT: It is not that new but go ahead.

MR. SIESS: I have been hearing about it for a long time.

MR. RUBIN: Well, we don't have a complete modeling of the effect. I think that is what we are looking for. And it is a fairly large effort which we haven't been able to go forward and complete, at this point in time.

And what we have done in the PRA reassessment is to attempt to model, as part of the scoping analysis, how serious the potential impact of relay chatter would be. Those results have indicated to us that it is non-trivial and we are going forward. We hope to eliminate relay chatter as a serious contribution.

MR. WARD: What do you mean, you hope to eliminate it? Do you mean that you hope that the study is going to tell you it is not a serious contributor; is that it?

MR. RUBIN: We will complete the study to determine if actions have to be taken such as chatterless relays or other system modifications to reduce its potential impact.

MR. SIESS: Does your analysis look at whether the consequences of relay chatter are easily known to the operator?

It seems to me there are two categories, the relay chatter concealing something or actuate something and the operator would know it. And then he would have some probabily of being able to correct it.

And the other possibility is that something will happen as a result of relay chatter and the operator will not know it has happened. Now, we had an incident recently where somebody opened the wrong DC breaker, DC switch, and it took the plant about 30 minutes to figure out what happened. Something had happened wrong and they didn't know it was wrong. And there is a big difference between knowing that a breaker is open and it should be shut -- going over and hitting the button, and having oddball things going on in the plant and not knowing it.

Is that something you are looking at?

MR. RUBIN: The second part is -- a major part of our concern but we have yet to develop a detailed process for completing it. What we have done is convinced ourselves that it is potentially serious and indicated we wish to go forward in a great amount of detail.

MR. SIESS: Are plant simulators sufficiently sophisticated to introduce random-type things like this?

I mean, a simulator has all the -- of a lot of computers sitting behind there to represent things.

Are any of those sophisticated enough to produce random --

MR. RUBIN: I have no way of knowing.

MR. WARD: I don't think they are designed to model electric surges.

MR. RUBIN: They are not.

MR. WARD: Well, you would have to put it in as a fault or a -- whether they have a -- I mean, I guess the interesting aspect -- where you can put in a transient fault which might be characteristic of this.

MR. SIESS: A computer that puts them in without -- I was just wondering if --

MR. WARD: You say the staff sees this as a serious problem but --

MR. RUBIN: Potentially serious.

MR. WARD: Oh, okay. Right.

But is there a program -- what sort of a program is it? Where is it addressed -- generic modeling or something? A tool for making this analysis, what sort of a program to you have underway?

MR. BOHN: I can comment on that.

There is a small effort with Future Resources Associates; Howard Lambert is the principal investigator on that, looking at the possibility of locking circuits and relay chatter.

These first came up, I think, in conjunction with an early PRA effort and there certain locking circuits were identified into load sequences following and it was identified that it was possible that there were self-energizing circuits that could preclude bringing some loads up on after you went on your on-side AC power and that was the source of the interest in this problem.

If one puts relay chatter into a PRA blindly and just assigns relay chatter to all the electrical components, one finds that it dominates the seismic PRA.

Now, it was mentioned that, perhaps, a code might be available that one could randomly input relay chatter and, during an earthquake, you would not have to put it in randomly because all the relays chatter that are not solid-state or otherwise protected.

So, the real problem is whether or not there are locking circuits, that is, circuits that, if the relay temporarily closes, they self-energize into a state that one didn't plan.

There is a potential tool available for analyzing this. There is a computer code that I am aware of, anyway, and exactly what complete state it is in, I don't know but there is a code that will take line diagrams of electrical circuits and search out for locking, that is feedback effects. And this is exactly what one is looking for.

MR. WARD: Well, is this similar to the old sneak circuit analysis?

MR. BOHN: That is part of it, yes.

MR. EBERSOLE: You said all relays chatter. Well --

MR. BOHN: I am sorry. I said all except, you know, solid-state or protected relays.

MR. EBERSOLE: I am talking about the mechanical, electromagnetic types.

MR. BOHN: In general that is --

MR. EBERSOLE: Well, we have to have relays in airplanes and we have got to have them in submarines and ships and other things. And, when this problem is encountered, the typical approach to it is to put them on a lug mount or something out the high frequencies to cause this sympathetic vibration and to pay some attention to the masses and spring constance of the relays themselves.

You are telling us, really, that we haven't done any of that.

MR. BOHN: Well, I know that a number of plant include time-delay circuits related to their relays.

MR. EBERSOLE: That is compensatory to relay problems.

MR. BOHN: Pardon?

MR. EBERSOLE: That is compensatory to the relay problem itself?

MR. BOHN: Yes, that is one way around it. There are various ways --

MR. EBERSOLE: The other way is to protect the relay against the inputs, which is put them on the -- he says it is --

MR. BOHN: I would think the effort involved in that would be so much in terms of identifying what type of isolation mounts you would have to have that would be much easier to have relays that were not susceptible.

MR. EBERSOLE: But is it generally true that the sum constants in masses of the relays structures makes them, virtually, all susceptible to chatter?

MR. BOHN: I can't answer that but I do know that relay chatter has been a common experience in earthquakes to date.

MR. EBERSOLE: Okay.

MR. WARD: Let me ask, does General Electric see this as a potentially important problem and, if so, do you have a program to address the sort of analysis that might be required to --

MR. HOLTZCLAW: Dr. Ward, we --.Kevin Holtzclaw from General Electric.

When the staff and their consultants brought up the concern with relay chatter they requested GE to look into the problem in, I could say, maybe, an overview fasion and try and get some kind of a handle on what it might mean relative to GESSAR. And it is, probably, less of a problem on GESSAR for a couple of reasons, both of which, I think, have been mentioned by members of the ACRS this morning. One being that a good deal of the electronics are solid-state so that, I think, the point that Mr. Ebersole is making, that most of that equipment is not susceptible to this type of a problem.

There are, however, switch gear protective relays that are included in the plant design, obviously, and so we did look at -- tried to track down those on line diagrams and whatnot to see what would be the potential impact and what we could divulge just from a quick look through of the plant elementaries and whatnot.

And we did identify a number of relays in, probably, the two key systems, the HPCS system and the RCIC system, which are, probably, the first lines of defense against a seismic event that could, ultimately, lead to core damage.

In looking at the relays that could be impacted, again, we found, in a number of instances, I think, again, another point that Mr. Ebersole was making, that the relays that we are dealing with here are fairly substantial. They are not the type, the small relays that might be involved with a component. And, although we are still looking at some of that to try and identify what the test basis is on some of those relays themselves to see what kind of seismic performance you might expect from them, but we, also, noted, I think, another point that Mr. Ebersole is making that there have been some attempts made with regard to isolating some of the frequencies coming from a large earthquake which would actually protect the relay against the chattering phenomenon.

Although, again, this is a fairly cursory review and we have not, really, completed the look-see that we started.

We, also, noted with regards to the RCIC, a turbent (phonetic) trip may occur due to the chatter of the agastat (phonetic) relays. However, you, also, have the capability to recept the relay from the control room. It is a fairly routine operation. It takes about five minutes for the operator to do. In the time window that you have got available to perform that function, is on the order of 30 to 45 minutes.

With regards to the HPCS system, protective relays for that system may need to be reset. And they would have to be reset at 69kv switch gear. That has some kind -- it is unlimited access and it would take, probably, about 15 minutes to reset. Again, you have got about a 30 to 45-minute time window available, assuming the failure of the RCIC system. You would have several hours time window if the RCIC system is operable.

So, those are the two key areas that we looked at. We don't have any geneeric program in-house to consider this in a lot more detail. I know that it is being considered as part of some of the overall fragility work in some of the Lawrence Livermore programs and GE is providing some input to those programs and, I believe, we be, at least trying to give them the information that we found as part of our review on the GESSAR.

MR. EBERSOLE: May I ask a question, sir?

If you know the problem in advance, it is no big deal to escape the consequence; is it? You just design to it; am I correct?

MR. HOLTZCLAW: That is correct.

MR. EBERSOLE: So, whatever it may be, the front line of the problem is in the old plants that are running today and need not be in the new ones.

CHAIRMAN OKRENT: Jesse, that may be so in principle but, I guess, what we are trying to ascertain is whether it is true for the proposed FDA?

MR. EBERSOLE: Well, then I get down to the generalities of the -- with FDA and say that we don't have sufficient prime structure in it to determine.

CHAIRMAN OKRENT: Well, we could write a mandate in it that we won't have it when we get through.

Well, I wonder if I could raise a few general questions to the staff.

If I recall correctly, you raised the question to General Electric: Why haven't you included design and construction errors in your seismic PRA and, if I remember correctly, they said, "We don't think it is possible to do that in a PRA." Correct me if I am wrong.

But where does that leave us? Is it the staff's conclusion that design and construction errors have not been important in prior plants or, if they have been important in prior plants, they have a basis for knowing they will not be important in future plants? And, if they don't have a basis for knowing they will not be important in future plants, how they are factoring design and construction errors into their own judgment.

MR. RUBIN: I don't believe I have a formal response for you and, I think, we would like to give it more thought preparing detail. I will say, though, that the PRA does not exist in a vacuum. We have tried to present what is generally accepted practice in presenting a PRA. We are definitely not saying that design and construction errors are unimportant. They, generally, have not been modeled and -- to date and we weren't developing new methodology to support the GE submittal.

However, hopefully, some of it is captured during the process of evaluating operating experience and we will learn from that. But we will, if you wish, we will try to provide you a more complete answer.

CHAIRMAN OKRENT: Well, I, in fact, would like to hear what the staff's answer is, at some future time and that time being before the ACRS completes its review of the

GESSAR II FDA. I don't think you can draw solice from the past, let me put it that way. And I see no reason to assume you will be able to draw solice from operating experience.

MR. SIESS: If so, that is very unfortunate because that is the only basis you are ever going to have for knowing what design and construction errors can do.

You only know the areas you find.

CHAIRMAN OKRENT: Well, let me, for the moment, leave that personal opinion --

MR. SIESS: You can postulate a design and construction error to affect anything in the plant. And, if you do that, you can just go on and on and on. So, I don't really know how you get at it.

In design of structures, we have attacked this problem for a period of about 15 and 20 years on a probabilistic -- using probabilistic-based design. We take care of design construction errors by simply calibrating our overall probabilities to past experience. That may be a hundred years of experience in building, most things have failed that can fail; all the possible things have happened, we think. And we believe that, let's say, factors of safety that will yield the same result now will adequately take care of design and construction errors, that most of them have occurred.

But there is no way of putting them in explicitly.

CHAIRMAN OKRENT: It depends on how you define adequately. I think you accept a failure now and then, like at Kansas City and so forth, benefactically.

MR. SIESS: Well, its failure rate has been acceptable to society and --

CHAIRMAN OKRENT: All right.

MR. SIESS: But nuclear plants have the same thing. We have failures that occur all the time but they don't lead to serious consequences.

But whether we have got a large-enough data base, I don't know.

CHAIRMAN OKRENT: Well, again, the staff is -- you are talking about remarkably low frequency of adverse consequences occurring for GESSAR II and the, I would say, the lower you are down the scale, the more vulnerable you are to design and construction errors in general and in the seismic area, certainly.

Could I ask a different question of the staff.

If I recall correctly, when the SSNRP study of the Zion plant was performed, they arrived at a rather different estimate of the uncertainties in the analysis than was presented in the PRA done for Zion by the licensee and, I think, although I am not sure, that larger uncertainties probably, than in any succeeding PRA that tried to do a thoughtful job on the seismic part.

What does this all mean? Were they wrong at Livermore? If they were wrong, how do you know they were wrong, assuming my original recollection is correct. If they weren't wrong, how do you input this into your evaluation and the decision making?

MR. CHOKSHI: I guess that the question is that all subjective judgment, in answer to this, assigned to a particular components or structures and the question of which one is correct is -- I am not quite -- I don't quite understand.

The question you are asking is: How we deal with the differences? Is that it?

CHAIRMAN OKRENT: Why don't I recommend that you read the transcript at your leisure and develop a response at a future time. There are several questions of this sort, including questions I raised in my introductory remarks. But you are not going to address them today.

Again, we would like to hear your considered and, hopefully, reasons, meaning justified opinions, at some future time.

Let's see, we are almost at the point, or a little beyond the point for a break.

Are there any further points the staff wants to make at this point in their presentation?

MR. SCALETTI: No.

CHAIRMAN OKRENT: I think we might as well follow the agenda, then, and take a ten-minute break and then we will hear from GE.

(Whereupon, a short recess was taken.)

CHAIRMAN OKRENT: We will reconvene.

MR. HOLTZCLAW: Dr. Okrent, you had asked us to identify the portions of our presentation when we do have some proprietary information. We do have some charts in this presentation that were taken directly from the study that have been identified as proprietary.

What I would propose to do, though, is to go through as much of the presentation as we can until we come to those specific charts and then I will alert you at that time.

CHAIRMAN OKRENT: Thank you.

MR. HOLTZCLAW: Originally, on the agenda, we had planned a short presentation on the deterministic portion of the seismic analysis that has been done for the GESSAR standard plant design. A good deal of the analysis work was done at the ACRS review and is part of the original FDA. Consequently, we decided that it would be fairly repititious and, probably, not worthy of time here and we want to progress with what has been done post-FDA, if you will.

So, we will dispense with that presentation. But we should point out that a good deal of some of the basis, deterministic engineering work that was done in support of that analysis was utilized in the seismic event analysis that deals, also, with the probabilistics.

This is important, primarily, in a couple of areas, one being the envelope approach used in the deterministic analysis and secondly, in defining the peak ground acceleration for the design -- for the design up to the SSE capability.

(Slide.)

Let me just tell you, briefly, what we plan on covering this morning. I will go through a discussion of the seismic hazard analysis, the structural fragility and component fragility work that was done in support of this study.

Dr. Deborah Hankins will pick up at that point and illustrate how we used the information in analyzing core damage frequency and in doing the risk portion of the evaluation. She will, also, cover some work that we did in something of an interactive mode with the staff and its consultants in the course of our review. What we did do, some sensitivity studies, specifically with regard to the fragility factors and the uncertainties in the fragility factors to assess the importance in the bottom-line results of core-damage probability and consequences.

MR. EBERSOLE: I think that the things you call components include those sometimes called equipment, as well.

MR. HOLTZCLAW: That is right.

(Slide.)

I would like to give you a little bit of background, not for the purposes of giving you the normal licensing fluff, but to give you some kind of perspective on how we ended up with the study, primarily, because, I think, in reading the SSER's, there seems to be more of a discrepancy between the applicant's material and the staff review, if you will, than, at least, I am familiar in seeing in other SSER's.

And, I think, it deals with a lot of the evolution of the requirement for this type of analyses as part of the severe-accident policy statement.

Do you recall back when the policy statement was first issued, it went through a number of revisions and, I believe, it was part of this SECY paper, 82-1(b), where there was more focus put on the external event analyses leading to and having an impact on severe accidents, specifically in section 9 of that draft of the SECY document, was the, I guess, the primary focus on looking at seismic in more detail.

At that time, GE, in doing the analyses relating to severe accident issues, had not performed any kind of additional seismic evaluation. The prime focus was on the internal event PRA. And, consequently, we are trying to deal -- work with the staff, actually, at how we are going to address this requirement in the severe-accident policy statement. In fact, at the time, GE considered a number of different approaches. In fact, we had talked to other consultants, including Jack Benjamin Associates and other -- in looking at what could, possibly, be done in this area, ultimately making a decision that we would do the analysis in-house.

The staff, at the time, was to try and get some kind of a perspective on what the impact of seismic is on severe accidents. It wasn't -- at least, it wasn't GE's intent, at the outset, to do a study that would be typical in the resource expenditure and level of detail of the internal event PRA.

In retrospect, that might have led to some of the problems that we have seen today with the differences of opinion between the SSER and the GE analyses. However, that was the approach that was taken after a good deal of discussion with the staff and staff management.

The principal tasks of the study were to look at the seismic hazards and establish a seismic hazard curve for use in the study, look at the structures and components and hardware to assess their fragility, evaluate the core damage frequency and then get some kind of an estimate of off-site consequences.

At the outset, we knew that there would have to be additional work done on a specific plan application, primarily, because we were, specifically, in the seismic hazard area, not defining any specific site nor the geological implications of any specific site.

(Slide.)

I am going to be discussing that aspect of the hazard curve in more detail because, at the outset, simplistically assume that that would be one of the key parameters that would have to be considered on a site-specific application.

Since that time, I think, we would agree with the staff that, based, maybe even more, on the amount of work that is being done in fragility analyses, that, at the time of a specific plant application, it would be appropriate to review all the assumptions in the seismic study that GE performed against the available new information that might come up prior to a specific site application.

This flow chart shows, simplistically, what we attempted to do in our seismic analysis. We wanted to identify the systems that were important to core damage, identify the components in the system and what their important functions were.

Looking at the plant configuration, and in the first two blocks it was a lot of the information coming out at the internal event PRA figured very strongly into the work relative to seismic. We have done extensive systems analyses as part of the internal plant PRA. Consider that -- has been looking at the systems under seismic conditions.

We looked at a plant configuration primarily to review the layout drawings assessing, basically, any spacial commonalities or leading commong mode failure effect associated with a seismic and the shear.

Also, look at the structures that contain thosse components and then assess what the implications were of individual structural failures on the systems themselves.

I think the rest of the flow chart is fairly self-explanatory in assessing the components --

MR. EBERSOLE: I have a comment on the chart, just a moment.

Where it says "identify structure that contains the component", doesn't that too sharply dileneate? Don't you mean identify structures whose malperformance may influence the performance of the components?

MR. HOLTZCLAW: That is correct.

And you will, with an asumption that we made, really a simplifying assumption in the analysis that, if we assume the structure failure, we made the asumption that any of the components within that structure would also be failed.

MR. EBERSOLE: I know, but it doesn't need to be inside. For instance, we have numerous high stacks that are 150 feet away from diesel buildings that influence the performance of the critical structures.

And this specification that it contains is too narrow in scope.

MR. HOLTZCLAW: That is a good point. I guess there were a number of staff comments related to that one aspect, specifically with regards to the stack and what the implications are.

MR. EBERSOLE: That is only one case.

MR. HOLTZCLAW: That is definitely only one case.

In some of these areas we would hope to be able to recover conditions for those kinds of structures that -- some kind of an interface requirement.

MR. EBERSOLE: Yes.

MR. HOLTZCLAW: Because that can vary.

MR. EBERSOLE: It is an interactive proposition, no matter whether it contains it or not.

MR. HOLTZCLAW: That is right.

MR. WARD: I didn't get what the answer was, though.

Does your analysis accommodate these interactions or not?

MR. HOLTZCLAW: In some cases it does and in some cases it doesn't. I think we tried to readdress this in, primarily, response to specific staff questions on individual structure, typically, that were outside the scope of the GESSAR Nuclear Island, the stack being one of them.

But, I think, in the -- you will be hearing the staff consultant analyses and I think they considered further structures that GE did not, in the GE study.

MR. EBERSOLE: I suggest you have a look at Diablo Canyon, it has a few thousand --

(Slide.)

MR. HOLTZCLAW: I would like to talk a little about the seismic hazard analysis that was performed as one element of the seismic analysis.

This was, maybe, one of the first problems that was faced by GE in performing the analysis for a standard plant design, as to what kind of approach do you take on characterizing what is basically a site-specific parameter for use in an envelope design that is intended for numerous sites.

This was actually a very difficult proposition and involved a number of meetings between GE and the staff as for an appropriate approach. We ended up using published data from some very specific PRA's as well as some USGS information to try and characterize what we term a representative curve. I guess the terminology has been somewhat diluted because we have called it a number of things in the course of this review.

We tried to stay away from an actual bounding curve because we thought that would be inappropriate for a number of reasons, I think, that were elicited earlier this morning on trying to stay away from a safety analysis review, as far as definitely bounding things.

But, on the other hand, it proved to be somewhat difficult to get what you might consider as best estimate hazard curve. However, that was the approach we ultimately took.

The staff did have a number of comments and recommendations during the course of this decision process. I guess it was a suggestion that is really, ultimately been utilized by the staff consultants is to try and take a number of different sites and look at the implications of a number of different sites with a standard plant design.

We evaluated that at the outset of doing the hazard analysis and felt, at the time, that it was inconsistent with the timing and the schedule we were trying to complete the analysis on. And it seemed like we had a fairly large matrix of both soil conditions and situations so it seemed like it might be -- it actually seemed like there was a resource-intensive effort that we weren't in a position to support. So we ended up going with the approach of characterizing a single hazard curve.

We limited the probability of exceedence to 10^{-8}. I think there is a misconception in the SSER III reports that the staff has issued with regards to the cut-off value that we used on the seismic hazard curve. It wasn't specifically set at any specific (g) level for any reason; it was really -- what we ended up doing was characterizing the hazard curve and then limiting the probability value consistent with the probability values that we utilized in the internal event PRA.

So we didn't cut if off relative (g) level, we cut it off relative to 10^{-8} probability level. We felt that that was important in getting, maybe, a more consistent representation between seismic hazard core damage probabilities and risk of the external event versus the internal event.

CHAIRMAN OKRENT: Whose 10^{-8} earthquake do you have in mind when you say you are limiting something to 10^{-8}?

MR. HOLTZCLAW: None in particular, Doctor, I think we only wanted to show the hazard cu.ve which is the next chart. I think I can try and explain, looking at the hazard curve.

(Slide.)

CHAIRMAN OKRENT: Excuse me, I will repeat the question.

Whose 10^{-8} value do you have in mind? I mean, I have seen that curve and it is not clear to me on what basis you are planning to establish that, going up to a 10^{-8} seismic event.

MR. HOLTZCLAW: I think the basis was just consistency with the internal event.

There is no basis relative to the hazard curve itself.

CHAIRMAN OKRENT: Again, in calculating internal events, somebody gets some data and puts some judgment in and tries to develop a suitable -- and so forth and computes, then, different frequencies for different sequences, including some operation actions and so forth. And I have little doubt that, given four people trying to do this in isolation, that they wouldn't all come out with the same list of events that met the 10^{-8} criterian or not.

In the seismic area, if we took experts and put them in a room, separately, at the 10^{-8} level, I would anticipate a very considerable diversity of opinion unless you preselected your experts not to achieve it.

So, I ama trying to understand what you mean when you say you are taking a hazard curve that takes you out to the 10^{-8} frequency.

Even if we have a site selected, let's say, and the licensee tries to generate a hazard curve for the site, again, if he were to take a broad spectrum of opinion from seismologists and geologists in the country instead of going only to those who have, in the past, afforded license applications, I think he would get a very broad spectrum of opinion as to what was the (g) level that corresponded to 10^{-8}.

That is why I am asking: Whose?

MR. HOLTZCLAW: Aren't you really asking, Dr. Okrent, really the basis for the hazard curve, itself, because --

CHAIRMAN OKRENT: GE was the one who said, "We are going to take something out to 10^{-8} and I am just trying to understand --

MR. BOHN: Dr. Okrent, by cutting it off at 10^{-8} it is basically saying that there is going to be -- we are going to neglect in contributions below 10^{-8}. It is equivilent to saying in the internal event analysis and I don't know what you mean.

CHAIRMAN OKRENT: Oh, no, no. Excuse me.

I understand very much what they mean by deciding to go off at 10^{-8}. That is not my question.

But trying to decide what the (g) value is at 10^{-8}. Whose (g) value? That is what I am asking.

MR. HOLTZCLAW: Okay. I think that really comes from the explanation of the curve itself because it is a simple exercise to identify what the (g) value is given a probability number.

CHAIRMAN OKRENT: I am sorry, I missed something. Something is simple?

MR. WARD: Well, you have got the curve; you just have to look at it.

MR. HOLTZCLAW: That is right. But I want to make sure that is what Dr. Okrent's question is.

MR. WARD: I don't know what you are asking either, Dave. I think what you are asking is: Where do they get the curve? Is that what you mean?

CHAIRMAN OKRENT: No. I know where they got their curve but it is proposed, the GE approach, that somehow acceleration whose frequency is larger than 10^{-8} will be considered and I am asking: In whose judgment will it be that the accelerations are such that they have a frequency of 10^{-8} or greater? And what I am suggesting is, at least in my own experience both a decade ago and this year, I can get a rather wide spectrum of opinion at frequencies which are substantially larger than 10^{-8} per year and, at 10^{-8} per year, it seems to me, opinion will vary markedly.

MR. HOLTZCLAW: Well, we tried to get, I guess, at what your point is by doing a sensitivity study on changing the shape of the curve so that we ended up picking up a different (g) value at the 10^{-8} frequency. But, I think, what Dr. Bohn was saying was exactly how we actually did the analysis, that is, you really neglect the implication of anything at a lower frequency.

CHAIRMAN OKRENT: Again, that is not the question, though.

All right. Let it go on, for now, but not forever.

MR. WARD: Well, could I ask you: Are you going to tell us if you have come to any conclusion about whether it makes any difference what detail is like?

MR. HOLTZCLAW: Yes.

MR. WARD: Okay.

MR. HOLTZCLAW: This --

MR. WARD: I have to wait, though?

MR. HOLTZCLAW: No, not too long.

MR. WARD: Okay.

MR. EBERSOLE: May I ask, when I see the red line down there: What is the bend width of professional opinion that I should see instead of that small line --

MR. HOLTZCLAW: Let me show you the next curve, let me show that professional opinion.

I did want to say something, though, about the preceding curve.

At the time we did this study, there was a fairly limited basis of hazard curves available. And this is probably one of the problems in the staff's viewpoint as how we can characterize seismic hazards with one simple curve.

So, we did look at existing PRA's and those are the curves that you see plotted on this figure. We were not intentionally trying to bracket all of them, although we effectively did with, at least of these three or four studies.

(Slide.)

MR. HOLTZCLAW: The next curve, though, shows some information that was made available through the SSMRP program, shortly after GE submitted their report to the staff, and does show a much higher variability in seismic hazard curves.

And you see the green curve is the GESSAR curve that was used in the study originally with the tail dropping off at the lower portion of the curve.

Now, prior to the sensitivity analysis that we did, we used the Limerick, or the tail of the Limerick curve, as shown by the upper portion of the green line, here, where it splits off, and then assessed the impact on core damage frequency associated with using that portion of the tail of the curve, as shown there.

Dr. Hankins will be covering that in a discussion of core damage frequency.

MR. WARD: I guess I don't understand. The curve labeled number 1, there, is not the same as your GESSAR curve on the previous one?

MR. HOLTZCLAW: I think the difference being in whether it is effective peak ground acceleration or peak ground acceleration and there is a 1.25 factor in there.

MR. BOHN: That looks much more than a factor of 1.25.

MR. HOLTZCLAW: I will have tok admit this isn't the GE curve; this is the curve that was in one of the staff consultant reports.

CHAIRMAN OKRENT: May I ask a question.

Number 14, for example, which says, "Watts Bar-Livermore National Laboratories", is that supposed to be a mean, a median, roughly, or 95 percent confidence curve or what?

MR. HOLTZCLAW: I can't say with a hundred percent assurance, Doctor, but I believe these are interpo.ated to be mean curves.

CHAIRMAN OKRENT: I think so. They did a sampling of expert opinion.

So, there is some spread and I would guess it could be a fairly substantial spread, depending, again, on who you go to for your experts and how many experts you have.

Around curve number 14, for example, lower and higher. Okay. So, the departure from the green curve can be even greater among expert opinion than shown he:e but for, well, an eastern site.

MR. HOLTZCLAW: In fact, we did do a limited uncertainty analysis associated with the seismic analysis where we did try and put some kind of bounds on the seismic curve that we utilized.

I think we, also, received some criticism for the bases on which we --

CHAIRMAN OKRENT: Bad reference.

MR. HOLTZCLAW: On which we based our spread and it was probably legitimate. I think there was some additional, newer information, not necessarily better information but newer information that might have been referenced.

MR. WARD: Well, if I look at this, the Watts-Bar curve, number 14 there, and, if I go off to once in a hundred years at which there is some historical evidence, I mean, that just doesn't -- who is number 14? I mean, is there any -- do these people attempt to tie into historical records or is it -- well, I am probably asking more than is fair to ask you.

MR. HOLTZCLAW: More than fair to ask me because I have limited experience in this area.

But I really can't answer your question, Dr. Okrent.

MR. BOHN: Well, I am not totally familiar with exactly where this curve came from. I believe it is out of the eastern seismic hazard characterization -- and I don't recall the numbers, myself. I am assuming this is a median curve over all experts.

But, the point I did want to make is: Yes, they use the earthquake catalog for the particular region in trying to construct these. But they, also, use a wide variety of expert opinion and that tends to increase the uncertainty and push the curves higher.

But, the basic answer is: Yes, they attempt to correlate with the earthquake occurrence record. The problem is, they, typically, had just one or two large events, maybe a hundred years ago or 200 years ago like New (phonetic) and small, more frequent earthquakes at a much smaller range. So there is the presence of one large earthquake, several years ago, can influence these curves quite a bit.

MR. WARD: Well, there is no reactor at New Madrid at Watts Bar. I mean, there is an historical record, just for example, at Watts Bar back a couple hundred years, probably.

CHAIRMAN OKRENT: You think they had strong motion?

MR. WARD: No, but I think they had people who would have observed .2(g) in earthquake. I think that would have been a noteworthy thing in letters and diaries.

MR. SIESS: I imagine it was probably felt there but I doubt if it was felt at .2(g)'s.

MR. SCALETTI: May I interject something here?

John Reed will be using this same slide in his presentation this afternoon. If questions arise this time about the origin of the curves or -- maybe we could address them then?

MR. HOLTZCLAW: The only other significance is, again, that most of this information did come out after we completed our study. And, in light of that information, we might have chosen a different curve for representation of GESSAR. I kind of look at it from the standpoint of a zealous simplistic engineering viewpoint. You kind of squint your eyes and look at these curves; the green curve does not look that bad as a representative curve for -- it is kind of the approach that the --

MR. WARD: Except the tail, which is what --

MR. HOLTZCLAW: I am sorry -- with the tail that we used in the sensitivity study; that is a good point.

And that was kind of the approach that we were attempting to utilize in this study.

If I could have the preceeding chart on the discussion of seismic hazard analysis?

(Previous slide.)

MR. HOLTZCLAW: After a number of meetings with the staff that I mentioned earlier, we decided on this approach to consider a representative curve with the implicit understanding that the NRC was going to involve some additional subcontractor analyses which would look at very specific PRA curves and try and assess what the differences might be associated with using curves that could be better or worse than the curve that was chosen by GE to use in this study.

At that time, I think there were some very specific PRA's in mind that -- wherein the information has not been released but the staff was privy to, that they could use in their analyses. It turns out that the Livermore report came out very shortly thereafter, which provided a compendium of curves that could be used in these kinds of sensitivity studies.

At that time, maybe we looked at this rather simplistically, as it, again, was the consideration of the site specific application and, at least with regards to the seismic hazard curve, it was expected that this might become an interface requirement, if you will, relative to severe accidents and the seismic analysis, wherein an applicant that would be utilizing this study to address the seismic issues in severe accidents, would, then, have to look at their site specific hazard curve and see what the implications were, the site specific curve relative to the curve that GE used. And that was always our intent at the outset and I think it has been expanded a little bit to include some of the fragility information, as well.

MR. ETHERINGTON: Do you assume some statistical crack distribution when you estim^te your structural capacity capability?

MR. HOLTZCLAW: I am sorry; I didn't catch the first part of that, Dr. Etherington.

MR. ETHERINGTON: As part of it?

MR. HOLTZCLAW: Do you assume?

MR. ETHERINGTON: A statistical crack distribution.

MR. HOLTZCLAW: I don't believe so. I really shouldn't answer that question. I really don't know but I can find out for you.

MR. ETHERINGTON: Most structures fail, when they do fail, as a result of a defect; isn't that true?

MR. HOLTZCLAW: That's right.

I believe Dr. Galry (phonetic) in the structural area, did take that into account because that would have been consistent with what we did do in the internal event study when we looked -- specific, when we looked at the containment structure. But I will have to verify that for you.

(Slide.)

MR. HOLTZCLAW: What I would do is talk a little bit now about the structural fragility evaluations.

This was a fairly standard approach that has been used in past PRA's to develop fragility curves to assess the capability of the structures as a function of peak effective ground acceleration. And you may not recall, but it was at the ACRS full committee meeting, I believe it was in about April of 1983, with Dr. Ed Chitz (phonetic) from General Electric made a short presentation to try -- and I guess, at that time, it was looking at seismic margins and he put a long equation on the board, trying to identify specific elements of the design wherein we believe seismic margin exists. And it was really, I guess, the work that we did, relative to structures, is really based on, kind of, Dr. Chitz' work, at that time, or, maybe, his perception at that time, where we went through and did identify specific parameters where we believed that the design had capability in excess of the normal design kinds of calculations relative deflections.

And that is really the approach that we took that we will be talking about on our next few charts, here, was to go in in each individual area, try and identify factors which contribute to an overall factor of safety, if you will.

I think this is fairly consistent with what's been done in previous PRA's, although I think some of the numbers that GE came up with have been -- are a little bit different than what you may have seen in previous studies.

Part of this, we, also, wanted to look at the critical structures, define their capacity factor of safety and, then, convert that into a structural capacity in terms of acceleration capability. And, from that, develop a fragility curve for the structures.

(Slide.)

MR. HOLTZCLAW: The next chart just shows an overview of the key structures that were considered. It is the RPV pedestal, the containment drywell wall, the containment vessel, itself, shield building, the auxiliary building, some other seismic category 1 structures that I will talk about and some limited work on non-seismic category 1 structures.

(Slide.)

MR. HOLTZCLAW: This chart that I have marked up a little bit, in comparison with what you have got in your handouts, identifies the factors that we did consider.

The overall capacity factor of safety is really a combination of two factors. I have an inherent strength factor that is inherent with the structure itself, and then, what we call a structural response factor which has to do with the response and the interaction-types of factors.

What I would like to do is, just, go through each of these and give you some perception on the bases that we utilized. This is indicated more thoroughly in the report which, also, points out the references that we used in defining the individual factors themselves.

The first factor is the load margin factor. The GESSAR II seismic analysis, the deterministic seismic analysis, is contained in appendix 3(a) of the GESSAR documentation. This appendix was generated prior to the standard review plan 3.7.1, the seismic design parameter, the standard review plan.

In subsequent analyses that GE has performed have shown margins that are in excess of those that were identified in the original appendix 3(a) values. That is load capabilities beyond those that are normally included or defined as the design load. So we calculated this load margin and that value typically falls between the value of one and the value -- as high as 4.5 for the structures that we looked at.

Now, this is looking at different potential failure modes, too, so we were looking at the loads and tension and compression and shear load. I give you that range just to give you some kind of a ballpark idea on the value can be -- or what the range of the values are.

MR. WARD: What was the range, again, I am sorry.

MR. HOLTZCLAW: As values from as low as one or no margin, to as high as the value of 4.5.

MR. WARD: Okay, fine.

MR. HOLTZCLAW: In the seismic event analysis has a series of tables in section 3 of the report that considers all of the structures in the potential failure mode and then shows you what those values are. It lists all the values in those tables.

The next value is the strength margin. And, typically, what we are dealing with here, the structures that we are dealing with are concrete and some steel structures. And there are some effects, particularly concrete compressive strength ratios and the capability of increasing concrete strength with age and then allowing for the reinforcing steel strength and capability of the design beyond the normal yield strength capability that was used as part of the bases of the original analyses.

And, so, there is this margin and, again, there are some very broad ranges on what this margin can be, values as low as ten percent above the yield stress up to factors as high eight above the yield stress -- I am sorry, above the allowable stress.

And account for the capability of materials to deform past their yield without ultimate failure.

I have only touched on pieces of this one factor. There has been a lot more discussion in the report talking about the bases and the justification for the values that GE used.

MR. BOHN: May I ask a question?

MR. HOLTZCLAW: Surely.

MR. BOHN: Mike Bohn.

On your structural factor, normally one subtracts off the normal loads prior to evaluating that factor.

Was this systematically done in developing the structural fragilities or the fragilities in general?

In other words, you have certain normal --

MR. HOLTZCLAW: I understand that what --

MR. BOHN: -- temperatures that are there, regardless of the level of earthquake and that removes a certain capacity -- a certain portion of the strength, if you will, and then the remaining margin is that margin which can properly be scaled with earthquake size.

MR. HOLTZCLAW: I know what your question is, Mark, I don't recall the answer, but I can find that out and let you know this afternoon.

MR. BOHN: The second question has to do with the ductility factor. You have used effective damage acceleration in scaling your hazard curve and this had to do with -- it is really sort of derived from the idea that the damage that an earthquake does to a structure, it depends on the number of large-motion cycles. If you just have one large motion cycle, not much happens; if you have eight to twelve, like a typical damaging earthquake, then you do have damage.

Have you used that idea in defining effective hazards -- effective hazard curve acceleration and here we partly use the same idea in defining another factor on the strength. It would seem that there was double counting involved, here, if you will.

MR. HOLTZCLAW: I understand your question because the staff and their consultants, also, defined a potential for double counting here. And I really don't know the answer to your question.

A third factor would be the inelastic energy absorption factor. And that accounts for the fact that the earthquake represents a limited energy source. And structural components are capable of absorbing energy beyond the elastic limit without harm for the function. We have been consistent with previous document PRA's in using a typical value of 2.0 or 2.5, depending on the structure here. And I believe that the staff, in their evaluation, identifies it as one area where we were very consistent with what's been done in the past.

MR. EBERSOLE: In relation to what he ask, the old-style, super-conservative model was to combine the accident load and the seismic load. I think you are shying off from that here and there but not everywhere.

For instance, you take a containment at its load, I guess; do you not? A containment is considered loaded?

MR. HOLTZCLAW: That is correct.

MR. EBERSOLE: As though there had been a prior accident; is that correct?

MR. HOLTZCLAW: You mean pressurize it?

MR. EBERSOLE: Yes.

MR. HOLTZCLAW: I think that is getting to the same question that Dr. Bohn asked and I am not sure --

MR. EBERSOLE: Well, not quite because he is taking about --

MR. HOLTZCLAW: I understand what you are saying but he is talking about, really, the combination of either a steady-state load or, even, an accident load with the seismic --

MR. EBERSOLE: I am talking about the latter kind of load.

MR. VILLA: Rudy Villa, General Electric.

In the design calculations that we do, we actually do combine all accident and normal loads to calculate whether or not we meet allowable stress limits and allowable load factors on the containment.

Our calculations also show that we have margin even with the comparison to the design loads.

I don't know if that answers your question.

MR. EBERSOLE: Well, I think we are coming around, aren't we, to conclude that we don't need, for instance, to combine local loads with seismic loads.

MR. VILLA: That is correct, however --

MR. EBERSOLE: On the other hand, for a containment, you do it anyway.

MR. VILLA: That is right, and for equipment and piping and other structures.

MR. EBERSOLE: Yes.

MR. SIESS: I thought I understood but I

don't. I think the question was, and if it wasn't, I will ask it this way: When you express a margin for the seismic load, does that margin represent the multiple of the design seismic load that you can carry before it fails, in combination with the other loads?

MR. VILLA: I believe that it does because --

MR. SIESS: I makes a big difference whether the seismic is ten percent of the design load or a hundred percent of the design load.

MR. VILLA: I believe that it does because, when we calculate a load for any given component, we combine all of the loads to ensure that the calculated stress is below the allowable design stress. And so, any margin that would be measured would be measured beyond the design load.

MR. BOHN: But the issue here is that, if 50 percent of your capacity is taken up in a normal loading situation, then that needs to be substracted out and divided by the seismic load to have the proper multiple to scale for higher earthquakes.

MR. VILLA: That is correct but I believe you would measure, when you measure the capacity, you measure it in reference to the design load.

The design load gives you an allowable stress, given the condition, and, when you measure margin, you measure it based on the design load which has already included normal loads and accident loads and seismic loads.

MR. SIESS: But only the seismic is being subjected to this multiplier that you are calling a factor of safety.

MR. VILLA: Okay, now you are out of my realm of --

MR. SIESS: If I have got a 90 percent fixed load and ten percent seismic which adds up to a hundred and it turns out that the capacity is 200, that gives me a factor of ten on seismic. The seismic was only ten percent of it. I can multiply it by 11 and still not exceed the capacity.

MR. VILLA: I think that is correct.

MR. SIESS: But, if I have got 50 percent seismic and the total capacity is 200, I have only got a factor of three. This is an issue that has been kicking around for five years; I thought it was settled somewhere.

MR. VILLA: Well, I think that is correct but, although I don't understand exactly how these values were generated, if you are measuring the margin that you have as a factor, a capacity factor that you have, related to the design load, then you have to do a little more research to determine what factor that is on the seismic load because the seismic load is less than the load that is calculated for the design.

MR. SIESS: Well, this is confusing because the first three items on the list are, essentially, increases in resistance due to the various margins that are built into the thing and the remaining items on the list are decreases in forces due to various conservatisms and so forth in the analysis.

There really ought to be a numerator/demoninator-type thing there. And they all sort of multiply together.

MR. VILLA: They are all correct if you want to understand the direct influence on the seismic load; that is correct.

CHAIRMAN OKRENT: Mr. Reed?

MR. REED: I am John Reed. Let me make one comment.

What Mike said is correct. The proper way of doing this is in the numerator, there, you, of course, would substract out the normal load. But what GE did is, also -- you have to look at the denominator, too. That calculated stress was not just the SSE stress; they, also, had their normal loads in the denominator, too.

And so, that will actually -- I am not sure, overall, the possible combinations; you are always conservative that way. But the few cases that I looked at looked like they were conservative. In other words, the proper way is: You subtract the normal load out of the numerator and you subtract the normal out of the denominator. What they did was, in the actual calculation, there, of the load margin, was they left the normal load in both the numerator and the denominator.

It, certainly, would be very non-conservative to put a total design load in the numerator and then just use the earthquake load in the denominator. And that is, kind of, what I sense your conversation was really revolving around. You were not focusing on the denominator, too.

MR. BOHN: Well, we are agreed, then, that, in principle, one subtracts out normal loads in figuring this ratio because we wish to scale the higher earthquakes.

MR. REED: Absolutely.

MR. BOHN: So, it gets back to Chas' comment that it depends very much on the relative proportion of normal to seismic and, probably, then, these factors could vary for different pieces of equipment and we don't know exactly what the right factors are.

MR. REED: That is right. And my comment is: In my review, usually, they were on the conservative. But I don't think that is universal; I think you can, probably, invent some combination of numbers where it would be unconservative.

MR. BOHN: I guess, given the information that went into this, though, it would be a very easy thing to re-evaluate those ratios, the information must be there in this appendix 3(a)?

MR. VILLA: Sure.

MR. BOHN: It would be a trivial exercise for this, the ten structures involved, in components.

MR. WARD: Well, let's see, just so I understand.

You quoted as an example the fact that the load margins might vary from the different structures from 1.0 to 4.5. And by this different definition, those numbers would be a little bit different at this point. Do you know what we are talking about?

MR. SIESS: It could be a lot different.

MR. WARD: Well, I don't know; one to 4.5, that is a lot different right there.

MR. SIESS: I think what they are doing is conservative; but I am not sure.

The next question is --

MR. WARD: It depends on what you do with the numbers. We have not heard what they are going to do with the numbers yet.

MR. BOHN: Well, for structures, though, many of them are often -- the seismic load is the controlling load, so, in those cases, it would not be conservative.

For piping, where the seismic loads are, typically, 15 to 20 percent of your maximum allowable, it would be conservative. But, for structures, which is what this approach is primarily useful for, it would not, necessarily, be so.

MR. SIESS: Allowable load.

MR. BOHN: Yes.

MR. HOLTZCLAW: I think that was indicated in the Brookhaven report, if not in SSER III for the check calculations that were done with the factors that GE derived. They were found to be conservative, albeit they were not done for -- I don't believe they were done for every structure.

There is an additional factor having to do with -- there is a factor to account for the response spectra that has been used in design compared with the a more median spectra, if you will. The time history that has been used in seismic analysis was generated for GESSAR in the design calculations to envelope the NRC design response spectra. So there was a factor to account for a, maybe, more realistic spectral condition, if you will. And so, that factor was included in the F_{TH} and there is about a 40 percent affect on that one multiplier. That is a typical value, is on the order of 1.4.

There is, also, a factor to account for the damping values. Normal design practice is to use REG guide

1.61 and these values have been considered to be quite conservative, particularly at response levels typical of structural failure levels. And so, we utilized some reports by NUMARK to identify what the impact of this factor is. And it, typically, ranges from about a 20 to 30 percent factor. So, the typical value is 1.2 to 1.3.

There were three additional factors in the response portion of this overall factor, if you will. There is one that was to account for earthquake duration and it was, again, based on more or less historical data on how long a damaging earthquake would actually last.

The first is the time history that was used in the seismic analysis. And it turned out to be a smaller factor on the order of about 1.2, 1.25 in length.

MR. WARD: Can that fact -- double counting with your inelastic energy absorption --

MR. HOLTZCLAW: No, I believe one is the duration effect on the input and one is an effect of the material -- a more of a material property effect.

MR. BOHN: Well, but the factor on -- as derived by NUMARK and its compatriots, took a simple one degree -- system with lack of plastic properties for time histories, put 28 different time histories through it, propagated 12 cycles of strong motion and computed ductility.

That means, duration definitely was used in the definition of the ductility factor and the NUMARK Rudel (phonetic) thesis contains all the details of that. So, it is clear to me that there has been some double counting.

MR. HOLTZCLAW: Well, we did evaluate the impact of changing these factors, too, and found -- Especially for this one, it was a relatively small effect because the factor, itself, was relatively small.

MR. BOHN: My concern is not in its use here, but in its use in the effective damage acceleration which has shifted your hazard curve over by a factor of, roughly, a quarter.

MR. SIESS: Let me as a more general question.

It seems to me, what you have done, is to start off with what John Stevenson (phonetic) calls as code margins, the normal margin that is built into a nominal resistance divided by a nominal load. And then you modify that with a series of factors, some of the applying to the resistance, some of them applying to the load. And, at no time, have you actually tried to compute the actual resistance as modified by all the conservative assumptions in design or the actual load as modified.

You simply put these factors on top of a nominal factor.

MR. HOLTZCLAW: I think that is a very valid point and I think it was made by the NRC subcontractors and it really had to do with the analysis approach that we had available to start with.

In fact, I believe John Reed made some point to this in his evaluation, that there may be more specific alternative approaches to get at the same problem in a different fashion which GE utilized. And the thing is, what we did do is we utilized the design analyses that we had at hand, based on our seismic analysis, deterministically, and tried to utilize that as best we could in this study.

MR. SIESS: Well, I think the advantage to the other method is not only that it is -- I think it is clearly superior to get at an answer but it is one heck of a lot more transparent. I am not sure whether that is good or bad; it depends on which side of the fence you are on, I guess. But it certainly is a desirable feature.

I have problems with this, a question of double counting, a question of just what the ratio means. If there is some ratio of earthquake capacity to design earthquake level, and this is an awful difficult way of understanding how you get to it --

MR. HOLTZCLAW: There were two additional factors that were indicated here on the chart, some factors associated with structural modeling which is really not relevant to the GESSAR design but takes into account differences in, primarily, relative to earlier plant designs, looking at SRSS versus other types of modeling.

In the GESSAR analysis, the F_M value was always utilized as 1.0, as well as the factor to account for soil-structure interaction value utilized in the GESSAR analysis was 1.0.

MR. BOHN: The last factor, the soil structure -- I am sorry, Mike Bohn.

The structure interaction factor is often used to partially account for soil amplification, soil column amplification under the plant. So, if you have a site that has 80 to 100 feet of consolidated stiff soil, that increases the load into your structure.

Now, about a third of the plant locations in the country have that situation and I would thought, for a generic design, one would have included an approximation to that local site amplification in that particular factor.

MR. HOLTZCLAW: What we did here was really was the soil-structure interaction factor that we referred to here is more relevant to the analyses that we did deterministically in our envelope portion, where we did look at different soil-structure interactions and found that a range of different potential values, so, if you used, for a specific site, there may some margin just based on whatever that site is relative to the site that we envelope the design for.

I think we accounted for it in that fact so that the deterministic analysis and we were not trying to take any additional credit in this portion of the analysis.

MR. BOHN: That would be an acceptable way of doing it. Did you, in your load determination, did you look at sort of a worse case which is I described, 80 to 100 feet of fairly stiff soil?

MR. HOLTZCLAW: Yes, that is correct.

MR. BOHN: And that is what you used to amplify the soil motion over bedrock motion?

MR. HOLTZCLAW: Yes.

MR. BOHN: Okay. That is appropriate, then.

CHAIRMAN OKRENT: I am a little bit unclear about the full import of the last discussion.

You started with some kind of free seal (phonetic) acceleration; did you?

MR. VILLA: Yes.

CHAIRMAN OKRENT: And then you worked your way down to an assumed bedrock?

MR. VILLA: Yes.

CHAIRMAN OKRENT: All right.

In the end, I am not sure which comes first, free sealed or the bedrock, in ones thinking. I don't know what this curve means when you look at a mixture of sites, but I am going to believe it is an observation.

MR. BOHN: The key question here, I think, is where -- you said this plant is keyed on a .3 GSSE.

Where is that .3 GSSE? Is that bedrock acceleration, surface-ground acceleration or what?

MR. VILLA: What we have, in describing GESSAR and I believe in the staff's safety evaluation report on the deterministic review, is a range, a total of eight conditions that describe the range of the seismic envelope which would allow us to put this plant at somethinig like 90 percent of the sites in the United States. And that 90 percent is a number out of the air. Each site would have to satisfy these particular conditions that are defined.

And the range of bedrock is defined by velocities and, right now, I can't remember the shear velocities. I believe something like 600 to 3,000 or so, something like that.

But I can look up that answer instead giving you the answer.

MR. BOHN: Well, my question really was: How does one interpret this .3 (g)? Does it interpret it as a rock outcrop acceleration gotten from the entire data base of mixed rock and soil sites which is typically used in defining the acceleration of the site or does --

MR. VILLA: I think that answer to that is yes.

MR. BOHN: -- it include the amplification of the soil which considerably amplifies the surface PGA under these conditions of a moderate soil site --

MR. VILLA: I think the answer to that is both.

MR. QUIRK: Joe Quirk from GE.

Mike, in the early phases of our review on the GESSAR PDA, we assumed the horizontal ground acceleration was inputted at the base mat, or .3 (g) was inputted at the base mat. As we went into the final design phase of the review, the staff came out with some additional guidance, NSRP's, that allowed the input motion to be at free field and we used that in the final design.

So, we have .3 (g) in the free field. So it is less certain.

MR. HOLTZCLAW: I would like to skip the next curve in the handout, for now. Then we can consider it in detail.

(Slide.)

MR. HOLTZCLAW: This is one of the tables from the report, just to give you a feeling for values. In this case, it is for the drywell under concrete compression and what the values used for the individual factors were.

I would like to go through a discussion of as much non-propritary information as we can. And, I think, the only thing that I have got here is just a couple of tables that are right out of the report that you have, showing examples.

The next chart, generally, what we did to develop the structural fragility curve, based on the individual factors that we have discussed in the previous chart.

We defined the median value for capacity and then the median ground acceleration level corresponding to failure can be determined for each individual structure.

In this case, we assume that failure of structure would be defined as that situation that the inelastic deformation of the structure increases such that the function of the operability of safety related equipment cannot be assured. And we have made the assumption of the lognormal distribution and tried to assess, simplistically, the statistical variations and selected a coefficient of variation.

And the next curve gives you the eight individual structures and the values that we utilized in the study. Again, that is just out of the report.

(Slide.)

MR. HOLTZCLAW: What I would like to do now is just talk very briefly on the component fragility because that is -- and then that leads into discussions of the use of both the component structural fragilities in juxtaposition with the seismic hazard to then assess core damage probability that Dr. Hankins will be reporting on.

The objective of the analysis of the component fragility was to develop the fragility data for use in our evaluation. This, again, makes use of a number of PRA studies that were already available where we could lump things in terms of very generic components.

MR. EBERSOLE: May I ask a question.

What do you do with the somewhat complicated case where you lose the containment function, per se, but then you find you didn't need it anyhow? It looks like you didn't have a core-damage accident.

How do you handle that?

MR. HOLTZCLAW: I guess, for purposes of this seismic analysis, I believe that containment failure went directly to core melt and that is somewhat inconsistent with what we did do in the internal event study where containment failure did not have that one to one correlation, obviously.

We analyzed a number of sequences.

MR. EBERSOLE: Well, you can easily lose the containment function as a containment function without having full melt.

MR. HOLTZCLAW: I understand.

CHAIRMAN OKRENT: What was the median capacity acceleration for the weakest link in your containment? It was pretty large; wasn't it?

MR. HOLTZCLAW: Yes, it was, Doctor.

CHAIRMAN OKRENT: So, it is sort of an academic question, I think.

MR. HOLTZCLAW: In doing the assessment of the component fragility, we made use of -- a good deal of use of the internal event study to look at critical components as part of our systems analysis. And we identified a factor of safety for the components in a somewhat similar fashion that we did for the structures and then identified their fragility curves consistent with the approaches that have been used in previous PRA's.

(Slide.)

MR. HOLTZCLAW: In the next two slides, just provide an example for the pipe rupture as well as a compilation of the median capacities for the components used in our analysis.

MR. BOHN: Could you go back to that last slide. I am sure this point has been made in the staff review.

(Previous slide.)

MR. BOHN: This ratio is appropriate to component failure where the failure is, primarily, anchorage failure and I am sure John Reed and -- the parts have been brought out.

Anchorage failure is a form of component failure and they are estimating the anchorage load and scaling them by ductility, et cetera, is an appropriate way to go. It, certainly, is not appropriate for components whose failure is functional, that is, relay chatter, circuit breaker trip.

In particular, you have identified stem binding on pumps as being your dominant failure and I don't think that this approach with its scaling factor is appropriate for stem binding a pump because that is a functional failure; there is no ductility involved in that, for example.

Same problem with coder-operatored valves and stem bindings there.

In addition, a second comment that I am sure has been made somewhere is that the use of effective ground acceleration which is scaled on ten to twelve cycles of damages done in motion is not appropriate for components whose failure is functional. So, in evaluating these components with function failure, one should not use the probabilities off the scale effective hazard curve, but rather use the full hazard curve with this extra factor of 25 percent removed.

MR. HOLTZCLAW: I believe that comment was made in -- part of the reason why we did go back and look at sensitivity on that component values that we used in the study.

CHAIRMAN OKRENT: Could I ask a question concerning anchorage.

It is my impression that it is not uncommon for there to be defects in the fabrication that is involved in anchorage in particular, for example, the welding. But there are other kinds of defects.

In other words, if one looks at prior experience, this is not a low probability event. Furthermore, it is of the nature that, in fact, it could drastically change your estimate of fragility.

Is it reasonable to ignore prior empirical knowledge and assume perfection? If so, why? And, if not, why should I assume some rather arbitrary subjective modification of fragility in a purported sensitivity analysis is adequate to cover this particular deficiency that, as I say, has been observed not as a rare event?

MR. HOLTZCLAW: In answer, I think, to the question. We did not assume any specific affect on the fragility curve other than what, I guess, what has been the past practice in PRA's and that is, probably, a deficiency in that regard.

I, personally, don't have a good deal of knowledge in how we might -- or what might be the appropriate factor to use there.

CHAIRMAN OKRENT: Well, let's see.

How do we figure out what the likelihood of a valve failing or a pump failing? You go back and look at data.

MR. HOLTZCLAW: Right.

CHAIRMAN OKRENT: It is not obvious to me why one doesn't go back and look at data of this sort. And, unless you have some valid reason for saying that the data would be different --

MR. HOLTZCLAW: I know what you are getting at, Doctor, because we tried to do this a little bit when we were looking at our fire analysis because we got with the staff and, really, as part of addressing the design deficiencies or problems associated -- the construction error problem.

I think that what you are really identifying is a classic in that area.

We did address it -- I mean, we didn't address it, we did consider it and we were trying to figure out a way to factor that into the study in a couple of different areas. The problems that we were running up against was that you could have some things like LAR reports and some kinds of reports that identified the failures or identified the problems in specific construction errors. I was thinking more in the fire area and the installation of dampers in the wrong place or lack of installation of dampers.

But it hard to come to grips with what the total data base might be on how many successes you had, how many times you are able to do it right to, maybe, put this into some kind of a little -- or eventuary (phonetic), if you will, to put some level of confidence on what an estimate might be in the affect to fragility.

That is, probably, a very simplistic answer to your question which, basically, says that we did not consider that aspect in the analysis.

MR. ETHERINGTON: Now, I would like to pursue that a litte, if I may, Mr. Chairman.

There has been a tremendous amount of work by NRC and others in the integrity of reactor vessels, particularly in connection with PWR's and there has been a tremendous amount of development of fracture mechanics in placing the integrity of the vessels.

In all of this work, there is an asumption that cracks will be present on some statistical or other distribution. It seems to me, here, you are taking advantage of a statistical spread in physical properties, tensile strength and so on and not taking any debit against the fact that you, surely, have defects in structural materials.

I think, in this area, you are far behind the approach that is being applied to reactor vessels using fracture mechanics. In fact, fracture mechanics doesn't seem to have entered into the vocabulary, even, in anything I have heard today.

I think there is a weakness there.

MR. HOLTZCLAW: I think that just from the standpoint, though, that were there is data available to back up the component or structural fragility, and I think you more hear about component fragility, there are fragility curves that have been based on some test work and I would expect that those components would be as amenable to having a crack initiated or as any other component that might be used in GESSAR, from the standpoint that the fragility curve was based on some data that would evidence that kind of a problem and, okay, maybe, second order, you are considering the affect.

But it is not being highlighed as a separate affect of its own. And I think that is what you are kind of getting at, Dr. Etherington.

MR. ETHERINGTON: But I still repeat that I think the great majority of industrial failures have been due to defects in materials.

CHAIRMAN OKRENT: By the way, there are, at least, I guess, two classes of defects. One might be flaws, if you will and there is another class where you don't have the material you thought you ought to. I mean, it might even have the right chemical composition but had been heat-treated differently, making it, again, the wrong material.

MR. BOHN: May I make a comment on that.

When we are dealing with supports, certainly what test data there was, primarily from the safeguard, U.S. Army Corps of Engineer program, they could only test a limited number like four pumps and 27 relays, for example, is what the data base is, as I recall.

But the other side of the question, as far as fracture and flaws in supports is that most of these pieces of equipment are anchored in a very redundant fasion. That is, a pump has four supports or four bolting places or else it is, typically, welded along one side, so the presence of a flaw, you have to hypothesize a flaw in more than one support in order for it to become significant.

And that is -- one could, probably, go through statistical arguments showing that it is not likely that, in four lugs used simultaneously. But that is something that could be looked at, I suppose.

CHAIRMAN OKRENT: Unless there was bad welding practice and so it was not random. And that, in fact, is what you find in prior experience.

MR. HOLTZCLAW: The common mode failure of that kind of a practice.

CHAIRMAN OKRENT: Or a bad seet of bolts.

MR. HOLTZCLAW: And universally heat-treated incorrectly and you get all four of them fasten this component.

One point of information here and, I guess, this is, primarily, brought out in the interaction with John Reed and some of our consultant people at GE. I think, in doing this study, it kind of opened our eyes up to an area that we had only been limitedly involved with, that is really, the extension of the seismic analyses beyond what we normally had done in the past on a deterministic design basis standpoint.

And we, in-house, had looked into getting more information on components that GE, typically, deals with on our reactors and; because of the interaction with some of the people at Lawrence Livermore, our working with them and trying to provide additional data on the components that we are using in our design.

I guess it was a little bit of an item of interest to me, personally, and to the team that worked on this report, to discover that the data base is extremely limited. But it, also, is -- there are extensive ongoing programs to better characterize that data base and we have some input to some of those programs.

What we would to do now, Dr. Okrent, is to shift into some more of the systems analysis area, if you will, and --

CHAIRMAN OKRENT: Could ask a question.

According to the agenda, we were going to break for lunch about noon. Is this a good breaking point?

MR. HOLTZCLAW: Yes.

CHAIRMAN OKRENT: Why don't we, if everyone is agreeable and, even, if they are not, recess for lunch and try to be back in one hour.

I don't know what the capability, the capacity factor is, for the existing dining facilities. They usually have two and they have lost one since we were last here.

But, anyway, let us try to be back in an hour.

(Whereupon, at 11:55 o'clock a.m., the open session was adjourned, to be reconvened in closed session at the hour of 1:00 o'clock p.m.)

AFTERNOON OPEN SESSION

3:30 p.m.

CHAIRMAN OKRENT: The meeting will reconvene.

It occurs to me -- I am not sure if we heard what was the risk contribution of utility supply systems during the prior discussion.

Did we hear that?

Maybe the NRC has answers to this. We can ask GE when they get back. In any event, why don't we start with the next agenda item.

MR. BARI: My name is Robert Bari from Brookhaven National Laboraties and I will provide some opening remarks on the general approach to the Brookhaven review of the GESSAR seismic PRA.

(Slide.)

MR. BARI: Just as general background, Brookhaven has been under contract to the Nuclear Regulatory Commission for some years now, on various aspects of the review of the GESSAR PRA, which includes the internal event part of the PRA which was submitted to the staff at least a year ago, the external events which include the seismic analysis that you are going to hear about today and, also, a fire analysis. And, in addition, we have an ongoing review of the core and containment analysis including core degradation, fission product behavior and containment and eventual releasse from containment.

These studies have been carried out in an integrated fashion. Several people, over several years, participating in the effort.

(Slide.)

MR. BARI: In terms of the scope of our review has several elements. First of all, we have evaluated the overall GE methodology for loss of components and structures due to seismic events.

One of the key elements that you will hear about was the comparison with state-of-the-art PRA's. We touched base with the various PRA's that have been produced in recent years for purposes of comparison and contrasting the approaches.

We performed, in this analysis, limited, simplified calculations of event leding to core meltdown. I want to emphasize here that what you are going to hear today are analyses of events leading up to core meltdown. We are not presenting the results, the consequence-type analysis, the core meltdown-type of analysis associated with the seismic events. That would be forthcoming at a later meeting, I understand.

We have, basically --

CHAIRMAN OKRENT: Excuse me.

MR. BARI: Surely.

CHAIRMAN OKRENT: I need to understand what it is you just said.

There is some additional information that we should expect to learn about in the future concerning core meltdowns for seismic?

MR. BARI: The consequences, the behavior of fission products in containment and the behavior of fission products as they leave containment. That analysis is not presented here today.

CHAIRMAN OKRENT: As it relates to seismic?

MR. BARI: As it relates to seismic.

CHAIRMAN OKRENT: Thank you.

MR. BARI: We are just presenting core meltdown frequencies as a bottom-line risk indicator, here, today.

The types of things we have been doing -- we have been identifying alternative models, for example, hazard curves. You have seen some of those already. The BNL analyses was actually presented earlier by GE and you will hear more about it in a little while.

We have examined the study for completness. For example, we have augmented the critical components list for -- in connection with fragility analysis. We have reviewed the model asumptions in the GE seismic PRA. In fact, you will hear, specifically, about what we regard as the system dependencies in the PRA, our alternative approaches.

We have carried out sensitivity analysis and, finally, we have done some importance ranking assistance.

(Slide.)

MR. BARI: Some of the bookkeeping connecting with the nuts and bolts of the approach, the hazard and fragility analyses have been reviewed by Jack Benjamin Associates under contract to BNL and you will be hearing from John Reed, shortly, on the details of that review.

The systems analyses were performed at Brookhaven, mostly by Kelvin Shiu who is here right now and will follow John Reed in his presentation.

There have been close interfacing of these tasks between John and Kelvin over the the period of the review. We have, also, had several meetings with General Electric. I think that was evidence from the previous talk.

The study was intiated at Brookhaven in September of '83 when we received the first submittal from GE which did not include uncertainty analysis. We received a supplementary document in December of '83 which did include uncertainty analysis.

We submitted our draft report to NRR in September of '84 and I believe you have that report. And, as I said, these results will be input to our containment analysis that we have handled on a separate contract, NRR.

CHAIRMAN OKRENT: May I ask a couple of questions.

MR. BARI: Sure.

CHAIRMAN OKRENT: Are we going to hear from Brookhaven concerning the risk contribution of utility supply systems or is that something you did not look at?

MR. BARI: Utility supply system?

CHAIRMAN OKRENT: As this thing from Watson --

MR. SHIU: Kelvin Shiu.

We did not include, to any great extent, designs of plant.

CHAIRMAN OKRENT: Okay.

Different question. It says that the BNL draft report was in 9/84. I notice that the acknowledgement thanks members of the NRC for helping improve earlier versions.

What I wonder is: Is there any technical information that was an earlier version that we missed in the final one? Are there any opinions in the report of 9/84 that not all members of the BNL staff agree with?

Anything more we ought to know about the draft that is dated 9/84?

MR. BARI: As far as I am concerned, no. I am not aware of any information that -- in addition to what we have in the 9/84 draft that would be useful at this point.

Kelvin, do you have anything?

MR. SHIU: There are no differing opinions at Brookhaven, let me put it that way.

MR. BARI: At Brookhaven, no.

MR. SCALETTI: Dr. Okrent, you do have, I believe, copies of earlier Brookhaven correspondence with the staff. Are you implying that you don't have earlier copies?

Because, everything that was discovered, that went out for the FOIA discovery that we had, was turned over to the ACRS with the exception of the GE information, submittals to us which you people get routinely.

CHAIRMAN OKRENT: What I looked at in my most recent review of documents included something dated 9/84 and something else dated 10/84. If I had earlier things from Brookhaven, they weren't in my two-foot file at home, I am sorry to say. And I was just trying to see whether there was anything that I missed by only looking at these, okay?

Let me just, as an aside, ask if GE, at some point during this meeting, is able to add to this question that was on the last GE agenda item, on this contribution, of utility-supplied systems. You did show some fragility numbers. I wondered if you had, actually, ground them out and decided what the contribution to risk was. Was it negligible or whatever, if you meant the numbers included there.

But we don't have to do that now.

Are there anyother questions of Mr. Bari?

MR. BARI: I have one final comment on the opening remark by Dr. Siess on the word conservatism used in the BNL report.

It was not our intention, as apparently there was an inference, that, perhaps, we were advocating doing a conservative PRA. If that was what was inferred, then we have misled you.

It is true that the word conservative has been used in various places in the report. For example, it was mentioned, aspects of the GE analysis that we felt not to be conservative. What we meant there was, optimistic. Perhaps that is an easieer way to say it and we will go back --

MR. SIESS: What is wrong with "correct"?

Or you don't use the word "correct" in terms of probability?

There is a place, for example, where it said, "In this sense, the ultimate value of the representative and may or may not be conservative in all cases."

MR. BARI: Which section is that in?

MR. SIESS: Page 5-1 of the September, 1984 draft.

On the other hand, the values developed by GE are on the non-conservative side. So, you know --

MR. BARI: I think it is a question of the wording by the author. I think we will go back and look at that and try to present a less ambiguous --

MR. SIESS: There is a statement -- this is under sensitivity analysis and it says, "The analyses are definitely not bounding conservative analyses and will not be realistic or representative for all potential plants which may be located at different sites."

And that one really confused me because it says they are not bounding conservative analyses and are not realistic or representative and I didn't know whether that was two thoughts in one sentence or whether they are not realistic because they are not bounding. Do you see what I am --

MR. BARI: Yes, sure.

MR. SIESS: -- apparently didn't get as much help from the staff --

MR. BARI: Yes, I believe this is going to come out with John Reed's presesntation. If it is not, I hope we will make that more clear.

CHAIRMAN OKRENT: By the way, just as -- by today's GRS level --

Just so Mr. Scaletti doesn't think that I was born yesterday, I don't assume that, because we, let's say, if we sent copies of what you call letter report, as well as draft reports, that we are necessarily exposed to all of the technical interchange that may have taken place because there is a period before a letter report is allowed to be written.

Let me just leave it at that.

MR. BARI: I am through.

MR. REED: Dr. Okrent, most of my material, a good deal of my material has proprietary information in it, so I think, for the sake of implicity, you should consider my whole talk being under the propietary side of the recording.

CHAIRMAN OKRENT: All right.

We will go off the record.

(Whereupon, at 3:45 o'clock p.m., the open session was adjourned and the subcommittee reconvened in closed session.)

CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the UNITED STATES NUCLEAR REGULATORY COMMISSION in the matter of:

NAME OF PROCEEDING:

COMBINED GESSAR II RELIABILITY AND PROBABILITY ASSESSMENT

DOCKET NO.: NONE

PLACE: LOS ANGELES, CALIFORNIA

DATE: FEBRUARY 14, 1985

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission.

MICHAEL CONNOLLY
Official Reporter

Reporter's Affiliation
Jim Higgins and Associates

Choosani #1

GESSAR II - SEISMIC MARGIN

NO SPECIFIC SEISMIC MARGIN STUDY WAS CONDUCTED OF GESSAR II IN TERMS OF HIGH CONFIDENCE LOW PROBABILITY EVALUATION. SOME MARGIN INSIGHT OBTAINED BASED ON PRA RESULTS.

BASED ON THE REVIEW OF PRA FRAGILITIES, THE STAFF BELIEVES THAT GESSAR II DESIGN, IN GENERAL, WILL POSSESS MARGINS SIMILAR TO [redacted] THOSE FOR OTHER RECENT PLANTS.

THIS IS MORE EVIDENT FOR STRUCTURES BASED ON LIMITED FRAGILITY EVALUATION IN GESSAR II. FOR COMPONENTS, MORE DETAILED EVALUATIONS ARE NEEDED.

HOWEVER, TO ESTABLISH MEANINGFUL MARGINS, SITE SPECIFIC INVESTIGATIONS ARE NEEDED.

GESSAR II MARGINS ARISE NOT ONLY FROM THE CONSERVATISMS USED IN DESIGN PROCESS (E.G. USE OF SPECIFIED STRENGTH VS. ACTUAL STRENGHT) BUT ALSO DUE TO ENVELOPING DESIGN OF GESSAR II FOR VARIOUS CONDITIONS.

THE STAFF IS ACTIVELY INVESTIGATING THE SEISMIC MARGIN ISSUE GENERALLY. EFFORTS ARE UNDERWAY TO REVIEW RECENT PRAS TO ESTABLISH HIGH CONFIDENCE LOW PROBABILITY DATA FOR SEVERAL COMPONENTS AND STRUCTURES.

Chu... #.

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#2

GESSAR II SEISMIC EVENT ANALYSIS

AGENDA

o	INTRODUCTION	J. F. QUIRK
o	BACKGROUND	K. W. HOLTZCLAW
o	SEISMIC HAZARD ANALYSIS	
o	STRUCTURAL FRAGILITY EVALUATION	
o	COMPONENT FRAGILITY	
o	SEISMIC IMPACT ON CORE DAMAGE FREQUENCY	D. A. HANKINS
o	SEISMIC ANALYSIS SENSITIVITY STUDY	
o	COMPONENTS & STRUCTURES IMPORTANT TO SEISMIC RISK	
o	RISK EVALUATION	
o	CONCLUSIONS	

INTRODUCTION

- o BACKGROUND

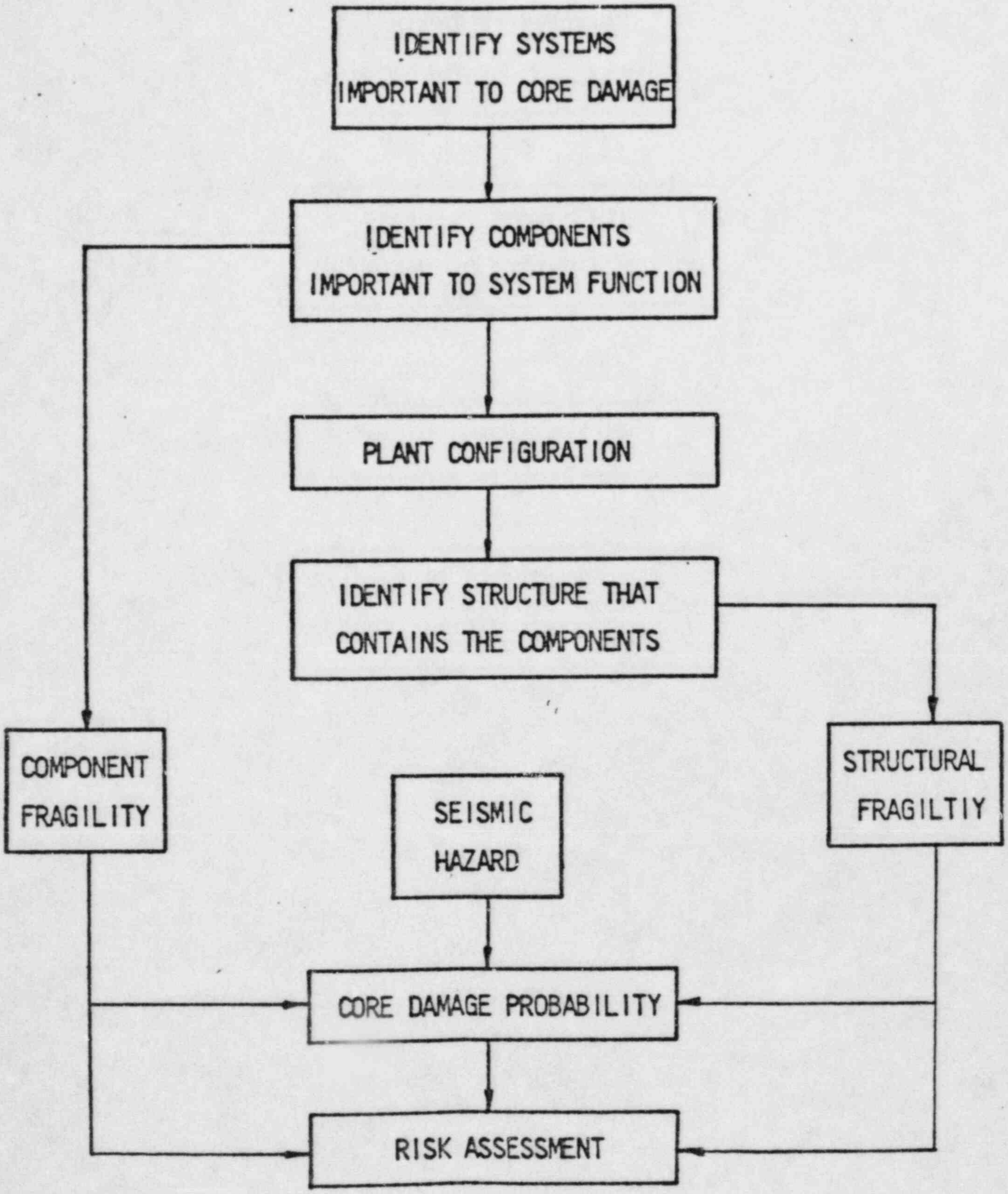
  STUDY PERFORMED TO MEET THE REQUIREMENT IN THE DRAFT SEVERE ACCIDENT POLICY STATEMENT

- o PRINCIPAL TASKS

  - ESTABLISH SEISMIC HAZARD CURVE
  - DETERMINE SEISMIC CAPABILITY OF CRITICAL STRUCTURES AND COMPONENTS
  - EVALUATE CORE DAMAGE FREQUENCY
  - ESTIMATE OFFSITE CONSEQUENCES

- o APPLICATION TO SPECIFIC PLANT SITE

GESSAR II SEISMIC EVENT ANALYSIS



SEISMIC HAZARD ANALYSIS

- O OBJECTIVE

  - o Characterize Seismic Hazard For GESSAR II Sites

- O APPROACH

  - o Published Data Used For Establishing Base Seismic Hazard Curve For GESSAR Application

    - \- Site Specific Analyses

      Zion
      Limerick
      Oyster Creek

    - \- WASH-1400 (NUREG-75/014) 1975

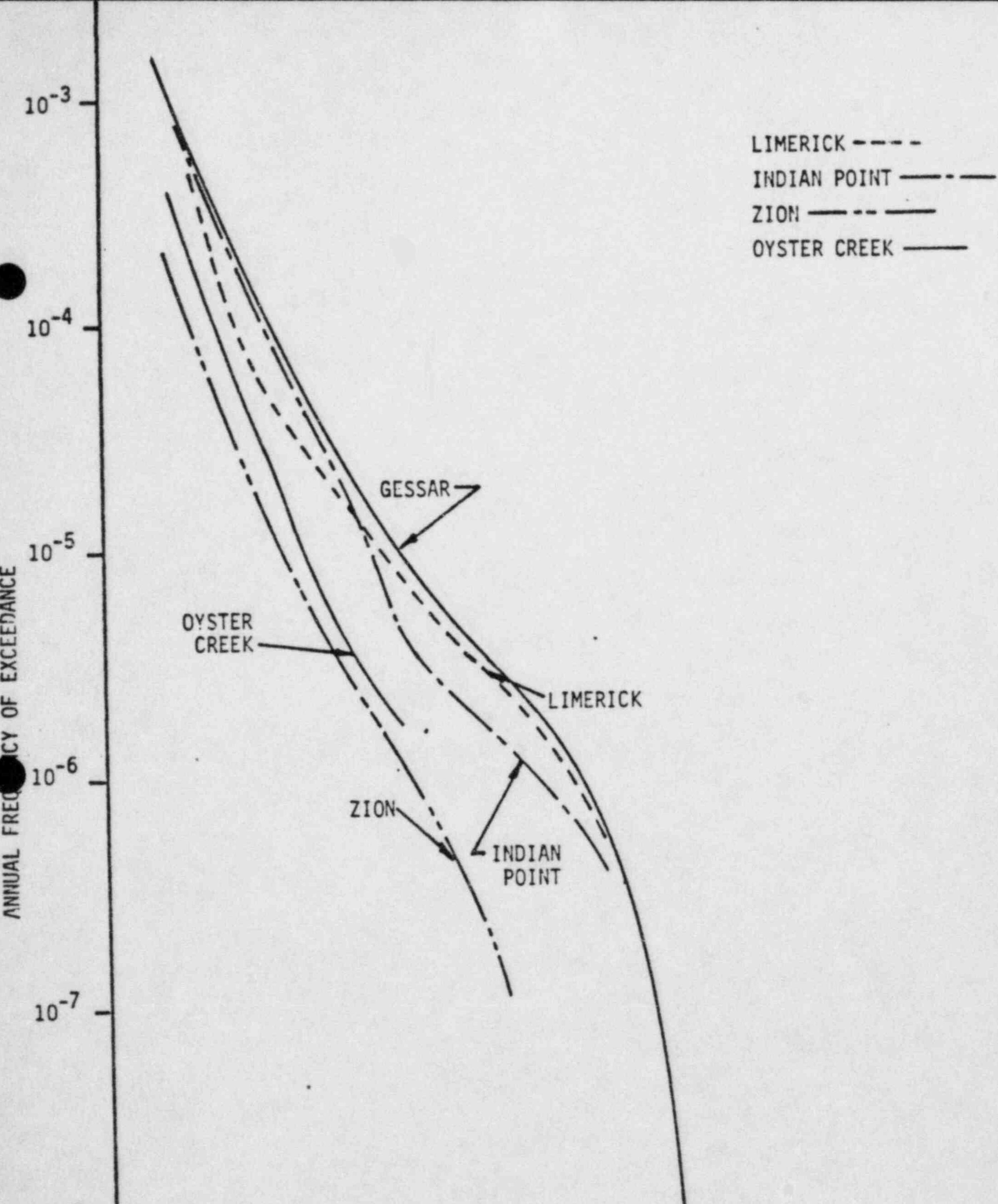
    - \- USGS Open File Report 82-1033, 1982

  - o Developed Characteristic Seismic Hazard Curve

  - o Limit Probability of Exceedence to 10^{-8} Consistent With Internal Event PRA (No Initiating Event Frequencies Less Than 10^{-8})

DISCUSSION ON SEISMIC HAZARD ANALYSIS

- NUMEROUS DISCUSSIONS WITH STAFF ON HAZARD ANALYSIS APPROACH
  - Suggestions on Considering Multiple Hazard Levels Coupled With Multiple Site Conditions
  - Meeting With Staff - Alternative Approach of Using High and Low Seismic Sites
    - Use Available Site Specific Information
- DECIDE ON PRESENT APPROACH
  - GE Consider a "Representative" Curve
  - NRC Subcontractor Would Look at Results Based on Hazard Information From Existing PRAs
- RECOGNIZED NEED TO CONSIDER SITE SPECIFIC APPLICATION
  - Intent: Applicant Define Site Specific Hazard Curve and Compare to Curve Used Seismic Event Analysis



GESSAR II Seismic Hazard Curve Compared to Hazard Curves from other Studies.

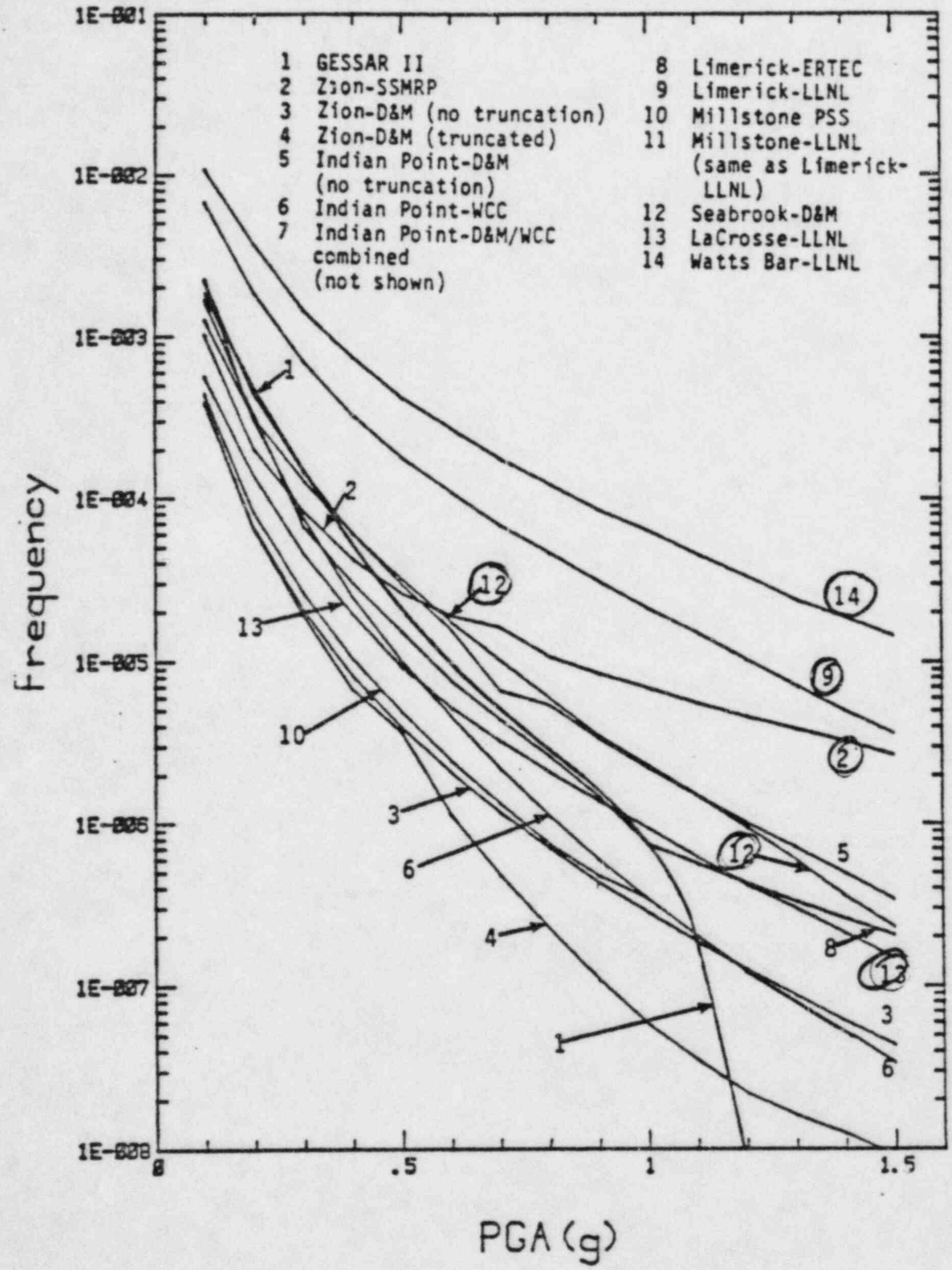


Figure 2-2. Comparison of the GESSAR II best-estimate hazard curve to the results of other seismic hazard studies.

STRUCTURAL FRAGILITY EVALUATION

- OBJECTIVE: DEVELOP FRAGILITY CURVES TO ASSESS PROBABILITY OF STRUCTURAL FAILURE AS A FUNCTION OF PEAK EFFECTIVE GROUND ACCELERATION

- APPROACH

  - DEFINE STRUCTURAL FAILURE:

    STRUCTURE LOSES ITS FUNCTION WHEN LARGE INELASTIC DEFORMATIONS OF STRUCTURE INTERFERE WITH THE OPERABILITY/FUNCTION OF SAFETY RELATED SYSTEM OR EQUIPMENT

  - IDENTIFY CRITICAL STRUCTURES

  - ESTIMATE "CAPACITY FACTOR OF SAFETY" (F):

$$F = \frac{\text{INHERENT ULTIMATE STRUCTURAL CAPACITY IN TERMS OF ACCELERATION}}{\text{DESIGN CAPACITY (OBE/SSE)}}$$

  - CONVERT F TO MEDIAN STRUCTURAL CAPACITY IN TERMS OF ACCELERATION

  - DEVELOP FRAGILITY CURVE FOR STRUCTURES

STRUCTURES CONSIDERED

- RPV PEDESTAL
- DRYWELL WALL
- CONTAINMENT VESSEL
- SHIELD BUILDING
- AUXILIARY BUILDING
- OTHER SEISMIC CATEGORY 1 STRUCTURES
- NON-SEISMIC CATEGORY 1 STRUCTURES

CALCULATION OF CAPACITY FACTOR OF SAFETY (F)

$$FFS = F_{\ell} \cdot F_{ST} \cdot F_{\mu} \cdot F_{TH} \cdot F_{D} \cdot F_{ED} \cdot F_{M} \cdot F_{SSI}$$

WHERE $F_{\ell} = \dfrac{\text{DESIGN LOAD}}{\text{CALCULATED LOAD}}$

$F_{ST} = \dfrac{\text{YIELD STRESS}}{\text{ALLOWABLE STRESS}}$

F_{μ} = FACTOR TO ACCOUNT FOR THE FACT THAT AN EARTHQUAKE REPRESENTS A LIMITED ENERGY SOURCE AND STRUCTURAL COMPONENTS ARE CAPABLE OF ABSORBING ENERGY BEYOND ELASTIC LIMIT WITHOUT LOSS OF FUNCTION.

$F_{TH} = \dfrac{\text{SPECTRAL ACCELERATION AT CRITICAL DAMPING NEAR FAILURE}}{\text{SPECTRAL ACCELERATION AT CRITICAL DAMPING FOR DESIGN}}$

F_{D} = FACTOR TO ACCOUNT FOR CONSERVATIVE DAMPING VALUES SPECIFIED IN REGULATORY GUIDE 1.61.

F_{ED} = FACTOR TO ACCOUNT FOR EARTHQUAKE DURATION

F_{M} = FACTOR TO ACCOUNT FOR STRUCTURAL MODELING

F_{SSI} = FACTOR TO ACCOUNT FOR SOIL-STRUCTURE INTERACTION

DEVELOPMENT OF FRAGILITY CURVE

- o MEDIAN GROUND ACCELERATION (A)

  = F * (OBE OR SSE)

- o LOGNORMAL DISTRIBUTION IS ASSUMED

  - STATISTICAL VARIATION OF MATERIAL PROPERTIES
  - SEISMIC RESPONSE VARIABLES ARE BEST REPRESENTED BY THIS DISTRIBUTION

- o SELECT COEFFICIENT OF VARIATION

  $P_F \approx 0.$ AT DESIGN VALUE.

COMPONENT FRAGILITY

OBJECTIVE

DEVELOP COMPONENT FRAGILITY DATA FOR USE IN GESSAR EVALUATION

APPROACH

- o SELECT CRITICAL COMPONENTS
- o ESTABLISH FAILURE CRITERIA OF COMPONENTS AS IT RELATES TO SYSTEM FUNCTION
- o ESTIMATE COMPONENT FACTORS OF SAFETY (F)

$$F = \frac{\text{ULTIMATE CAPABILITY OF COMPONENT}}{\text{DESIGN CAPABILITY}}$$

- o DETERMINE MEDIAN CAPACITY OF COMPONENT IN TERMS OF PEAK GROUND ACCELERATION (PGA)

MEDIAN CAPACITY = F . (DESIGN PGA)

- o ESTIMATE COMPONENT FAILURE PROBABILITY AS A FUNCTION OF PGA
  - LOG NORMAL PROBABILITY DISTRIBUTION WITH ESTIMATED COEFFICIENT OF VARIATION

#1-

BNL SEISMIC RISK ANALYSIS
SUMMARY OF GENERAL APPROACH

PRESENTED TO
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
INGLEWOOD, CA

FEBRUARY 14-15, 1985

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

BACKGROUND

BNL IS UNDER CONTRACT TO NRC/NRR TO PROVIDE A REVIEW OF THE GESSAR-II PRA, INCLUDING:

- INTERNAL EVENTS
- EXTERNAL EVENTS
- CORE AND CONTAINMENT BEHAVIOR

SCOPE OF SEISMIC REVIEW

- EVALUATED GE METHODOLOGY FOR LOSS OF COMPONENTS AND STRUCTURES DUE TO SEISMIC EVENTS.
- COMPARED WITH STATE-OF-THE-ART.
- PERFORMED LIMITED, SIMPLIFIED INDEPENDENT CALCULATIONS OF EVENTS LEADING TO CORE MELTDOWN.
- IDENTIFIED ALTERNATIVE MODELS (E.G., HAZARD CURVES).
- EXAMINED COMPLETENESS (E.G., CRITICAL COMPONENTS FOR FRAGILITY ANALYSIS).
- REVIEWED MODEL ASSUMPTIONS (E.G., SYSTEM DEPENDENCES).
- PERFORMED SENSITIVITY ANALYSIS.
- DEVELOPED IMPORTANCE RANKING.

APPROACH TO REVIEW

• HAZARD ANALYSIS • FRAGILITY ANALYSIS	PERFORMED BY J. BENJAMIN, INC. UNDER CONTRACT TO BNL

- SYSTEMS ANALYSIS (PERFORMED BY BNL)
- CLOSE INTERFACING OF TASKS
- SEVERAL MEETINGS WITH GE
- STUDY INITIATED IN 9/83; RECEIVED GE UNCERTAINTY ANALYSIS IN 12/83
- BNL DRAFT REPORT TO NRR IN 9/84
- INPUT TO CONTAINMENT ANALYSIS