UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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MEETING
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)
SUBCOMMITTEE ON THERMAL-HYDRAULIC PHENOMENA

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TUESDAY,
FEBRUARY 4, 2003

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 1:00 p.m., Dr. Graham Wallis, Chairman, presiding.

COMMITTEE MEMBERS:

GRAHAM B. WALLIS, Chairman
SANJOY BANERJEE, Consultant
F. PETER FORD, Member
THOMAS S. KRESS, Member
GRAHAM M. LEITCH, Member
VICTOR H. RANSOM, Member
STEPHEN L. ROSEN, Member

ACRS STAFF PRESENT:

MEDHAT EL-ZEFTAWY
MICHAEL SNODDERLY

ALSO PRESENT:

JOHN BUTLER
RALPH ARCHITZEL
DAN DORMAN
GARY M. HOLAHAN
B.P. JAIN
JOHN LEHNING
BRUCE LETELLIER
SUNIL WEERAKKODY

C-O-N-T-E-N-T-S

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

1:02 p.m.

CHAIRMAN WALLIS: The meeting will now come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards' Subcommittee on Thermal-Hydraulic Phenomena. I am Graham Wallis, Chairman of the Subcommittee.

Subcommittee members in attendance are Tom Kress, Victor Ransom, Graham Leitch, and Steve Rosen, along with our consultant, Sanjoy Banerjee.

The purpose of this meeting is to review two proposed NRC documents for resolution of Generic Safety Issue 191 entitled, "Assessment of Debris Accumulation on PWR Sump Performance."

The first document to be reviewed is a proposed NRC Generic Letter entitled, "Potential Impact of Debris Blockage on Emergency Recirculation During Design-Basis Accidents at Pressurized Water Reactors."

The second document is an associated Draft Regulatory Guide No. DG-1107 entitled, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident."

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

Med El-Zeftawy is the Designated Federal Official, and Michael Snodderly is the Cognizant ACRS Staff Engineer for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in The Federal Register on January 22nd, 2003.

A transcript of the meeting is being kept and will be made available as stated in The Federal Register notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

Representatives from the Nuclear Energy Institute will discuss their efforts associated with the resolution of GSI-191. We have received no other written comments nor requests for time to make oral statements from members of the public regarding today's meeting.

I'll just give you a very brief review of how we got here today. The full Committee was briefed on GSI-191 in September 2001 at its meeting. The Office of Nuclear Regulatory Research presented their recommendations for resolving the issue. Based on a generic study, RES found that an increase of sump screen surface area to reduce the vulnerability caused by debris accumulation on the sumps was net beneficial and recommended that plant-specific analyses be conducted to determine the vulnerability of individual plants to loss of net positive suction head margin.

In a September 14, 2001 letter to the Executive Director for Operations, the Committee stated that, if plant-specific analyses are required as part of the resolution, guidance for performing these analyses should be developed.

We'll now proceed with the meeting, and I call upon Mr. Gary Holahan of the Office of Nuclear Reactor Regulation to begin.

MR. HOLAHAN: Thank you, Dr. Wallis. I'm only going to make a few introductory remarks, and then the NRR and Research presentations will follow. I think you've already covered a significant overview.

As you stated, we're basically pursuing the issue of PWR sump screen blockage, based on research work that's been done to date, and now we're beginning to move into regulatory and implementation stages.

I just wanted to remind you that the

reason we're here with the ACRS is basically for two reasons. One is that the resolution of generic safety issues calls for ACRS involvement, and also because we have proposed that the resolution passed would require generic communication, in this case a Generic Letter requesting actions and information from the industry, but that would also call for an ACRS review. So we will be looking for the Committee's support in this activity.

Can I have the next viewgraph? We always, when we're in these sorts of studies, like to continue to remind ourselves of the safety implications, and if we are going to allow interim operation of a plant while a generic safety issue is being studied and resolved, we need to be clear in our own minds why that is appropriate.

So we've structured what we call justification for interim operation. Many of these are the same issues that we identified earlier on in the process. The fact is the particular LOCAs of concern would be relatively low probability and that there are some margins and conservatisms involved, but we continue to revisit these issues as we go on, because we know it will take some time to study these issues, especially as we go into a plant-specific phase, and also it will take additional time to implement any changes that might be necessary as a result of those studies.

I think the one thing we could say at this stage is we think these issues continue, the justifications continue to be true. In addition to the issues we identified earlier on, the industry has taken some steps over the last year or so which also provide us some additional comfort and margin with respect to continued operation. So the industry has some guidelines and has been identifying walkdowns and other cleanliness-type activities that industries can take as interim measures. I think we're comfortable with those.

Can I go on to the --

CHAIRMAN WALLIS: Gary, this probably gives you a good enough feeling, but these are not sort of quantified remarks. I mean these are qualitative things. What I think impressed the Committee last time we heard about this was that there is a real potential for this blockage to occur. So these are some sort of mitigating things, but they don't really make the problem go away.

MR. HOLAHAN: They are not reasons not to pursue the issue. They are reasons to put it within a safety context that allows us to take some time to continue to study it and to allow for a phased implementation.

CHAIRMAN WALLIS: Okay.

MR. LEITCH: As I recall, Gary, there's a very wide band of variables in the power plant: size of screens, gross size opening in the screens --

MR. HOLAHAN: Type of insulation.

MR. LEITCH: Right. And I was wondering if in the worst line-up of those cases, we feel we can still reach a justification for interim operation?

MR. HOLAHAN: Well, we haven't yet found any specific plant that has sort of the worst combination of all imaginable parameters. In my mind, if we came to the point where we found some plant which had a particular size/shape of screen and a particular location and type of material that led you to conclude that, if there were a pipe break, loss-of-coolant accident, that you thought, you really believed that the ECCS wouldn't work, then I think we would be at a point of saying that needs to be fixed, and not in the kind of timeframe we're talking about here, but if not immediately, in very short order.

MR. LEITCH: Right.

MR. HOLAHAN: So I don't think we would

want to hang our hats just on low pipe break probability. I think other mitigating measures that made you have, you know, if not the kind of confidence you would like to have in the emergency core cooling system, at least enough confidence that you think it really would work.

CHAIRMAN WALLIS: Well, looking at your last bullet, that isn't always reassuring. We've heard stories fairly recently of at least one plant which had a large amount of peeling paint.

MR. HOLAHAN: Yes.

CHAIRMAN WALLIS: And that's not reassuring because, presumably, that's ready to fall off and then get washed down to a screen.

MR. HOLAHAN: I think the part that's reassuring is, if the paint were going to fall off, it was going to fall off. The part that's reassuring is, actually, looking for those problems and dealing with them when they're found.

CHAIRMAN WALLIS: If it's hanging there waiting to be knocked off by a LOCA, it's not falling off.

MR. HOLAHAN: Right.

MR. ROSEN: We're also hearing --

MR. HOLAHAN: Yes, I understand. Remember that we issued, I want to say a bulletin, but perhaps a Generic Letter a year or more ago on this specific issue. So the industry has been dealing with it.

MR. ROSEN: We're also hearing of some plants that are actually already modifying their sumps.

MR. HOLAHAN: Yes.

MR. ROSEN: Is that something we're going to hear more about today?

MR. HOLAHAN: Well, I can mention two. We know that Davis-Besse has modified their sump, and also I understand that Diablo Canyon did. I don't know of other specific examples.

MR. ARCHITZEL: This is Ralph Architzel. We weren't planning to discuss those today.

MR. HOLAHAN: Do we know of any other plants? Those are the only two I'm aware of.

MR. ARCHITZEL: No.

MR. HOLAHAN: But we'll keep the Committee informed if there are other examples.

Can we go to the fourth viewgraph? As Dr. Wallis mentioned, we're here because we're at a stage for a number of activities. One is the Regulatory Guide, and the Draft Regulatory Guide is really basically going to be an update of an existing

Regulatory Guide, 1.82. And we are pursuing a Generic Letter, which will go out for public comment upon review and approval by this Committee and by the CRGR.

In parallel with that, there is an industry activity that I think you'll hear about later today to develop specific guidance, because I think we're all envisioning that this issue needs to be resolved on a plant-specific basis. There are so many plant variables involved that the Generic Letter isn't going to provide the level of detail for reviewing and resolving the issue on a plant-specific basis.

So we do expect, and we have been working with the industry, on a guidance document that can help. We expect to be sort of in the review and approval process, so that a little further down the line there will be a Generic Letter calling for information, but there will also be a guidance document to assist the industry in how to deal with the information request that the NRC puts out.

CHAIRMAN WALLIS: What is the level of what one might call model development competence of this industry for this problem?

MR. HOLAHAN: I think we ought to save that question for the --

CHAIRMAN WALLIS: I mean they are going to develop guidance, but the only guidance I've seen is go around and inventory something which could be debris. I mean that's just the very beginning of the guidance. The question of how it comes off, how it breaks up, where it goes, it's not a simple issue.

MR. LEHNING: Right, that is true, and that is the first part of the guidance, I think, that they issued that's got like a two-step guidance process. That was just to determine what source of debris we had in there now, what to do with it, and that's being developed I think currently. John Butler from NEI may talk about that a little later.

CHAIRMAN WALLIS: So he's going to reassure us that they know how to do it?

MR. HOLAHAN: Many the best analogy we can give you at the moment, having not come to the point of them giving us a final document and us reviewing and approving it, is just to remember that, when we had a similar exercise with boiling water reactor sump screens, we found the industry guidance to be very useful. It was scientifically-based. In fact, they went out and experimented on a few different alternatives, some of which didn't prove to be useful, but I think were well studied. So I'm at least optimistic that there's a track record here that this can work out.

Actually, the last thing I would like to mention, before we go on to the technical presentations, is the tailend of this process is, when we get to the stage of formally issuing the Generic Letter, we will receive responses for each plant. We'll go through a plant-by-plant review.

I think, as we did with the boiling water reactors, we may find a few unusual cases where we actually want to go into the field and see any construction. We might replicate some of the calculations, and, ultimately, we will likely use our Resident Inspectors to do some sort of checking to make sure that, whatever the resolution turns out to be on each individual plant, if it gets evaluated and checked off to some degree, and then the more difficult cases I think we'll do more review and analysis.

If there aren't any further questions, I would like to turn it over to Ralph Architzel to get into some of the technical issues.

MR. ARCHITZEL: My name is Ralph Architzel. I'm with the Office of Nuclear Reactor Regulation, and John Lehning and I are the reviewers for GSI-191 resolution.

Just to the overview slide now, this is the topics I'm going to discuss. I'm going to go over a little bit of history and how the Generic Issue Program works, sort of the results of technical assessment to try to refresh you somewhat as to where we stood when we received the assessment from Research.

John is going to go over the Generic Letter specifics, and B.P. Jain from the Office of Research and Dr. Bruce Letellier are going over the Reg. Guide. As we mentioned earlier, John Butler from NEI is going to go over the industry evaluation guidelines.

I've got some additional points to raise, like the support we're receiving in NRR from Los Alamos, what meetings we have had and initiatives we have been reviewing, and our current plans and schedule. That's an overview of my presentation.

The next slide. Generic Safety Issue 191 is found, in our eyes, in basically long-term recirculation requirements in 10 CFR 50.46 and Criterion 35 on ECCS performance in the regulations.

The debris blockages of the sump screens has the potential to prevent the injection of water into the reactor core or to contain the spray system, or to function and contain the spray system.

This is not a new issue in its entirety. USI A-43 did examine emergency sump performance. The NRC did close that issue with a Generic Letter recommendation, which was for information. So we weren't starting with a clean slate exactly. There was a regulatory analysis, a cost/benefit.

The regulatory guidance was changed at that time, but it was not backfit on the industry. It was felt that going forward the industry should take and mechanistically look, or the recommendation was made but it was not required for industry to mechanistically look at debris generation and transport associated with the sumps, but not imposed as a backfit at that time.

But when we revisited GSI-191 following the BWR events, where there was actual blockage with just SRV discharges, and there was in Limerick, where it wasn't even insulation that -- Barsebeck had insulation; Limerick had just miscellaneous fibrous debris in this spent-fuel pool that ended up in strainer deformation and blockage.

So then we did reopen GSI-191 to see if it's a credible concern around 1996, when we were done with the --

DR. BANERJEE: Where did Limerick fibrous debris come from?

MR. ARCHITZEL: They never identified the specific source at Limerick. It was not fiberglass latent.

MR. LEHNING: And this is John Lehning. Just to clarify, it was in the suppression pool, not the spent-fuel pool.

MR. ARCHITZEL: Right, I forgot. I meant suppression pool. Excuse me.

So it was not identified.

CHAIRMAN WALLIS: They knew what it was surely?

MR. ARCHITZEL: I don't think they ever clearly identified it.

CHAIRMAN WALLIS: Some mysterious substance?

MR. LEHNING: It was just a fibrous substance, I think. They didn't identify where the fiber had come from, but they knew it was fibrous debris.

DR. LETELLIER: At least anecdotally I understood that it was cellulose air filter that had fallen into the suppression pool.

MR. ARCHITZEL: Was that Perry? That

might have been Perry. That was Perry. There were other incidents. At Perry they did have that incident that was the source of the fibrous debris.

DR. LETELLIER: Was Graham Leitch at Limerick at the time?

MR. LEITCH: No, it didn't happen on my watch.

(Laughter.)

MR. ARCHITZEL: But there were more events than just --

MR. ROSEN: ACRS claims no responsibility.

(Laughter.)

MR. ARCHITZEL: May I have the next slide? I guess the thought was that the graphic is up there just to emphasis that we have a seven-stage program. The first three stages of the Generic Issue Program have been completed, which is the identification in 1996, the initial screening done by Research, and then we have a formal assessment phase. That's the one you heard about in 2001, when it was turned over to NRR.

So, currently, we're in the regulation and guidance development phase and, as Gary mentioned, we are developing the Generic Letter and the Draft Guide.

Then following that, we do have the phase of issuing, implementation, and verification. So that just lays out our management directive process for how have Generic Issues of treatment.

I would like to say, as far as the Generic Letter or Generic Issue and the ACRS role, you are asked to comment on Generic Issue resolution and provide guidance. It's an option to provide or to review a Draft Generic Letter. I think you've taken that option. It would allow you not to do it or do it; it's your choice really.

CHAIRMAN WALLIS: Well, just speaking for myself, I think that your approach in the Reg. Guide looks reasonable, and you asked for all the good things. The question that's in my mind is whether industry knows how to supply those kinds of things and whether you know how to recognize the good thing when you see it. So just issuing the Reg. Guide doesn't assure that things will work out appropriately after that.

MR. ARCHITZEL: I understand.

CHAIRMAN WALLIS: So those are the questions I have, and you can ask people to do analyses. If they don't know how to do it, then it doesn't solve the problem.

MR. ARCHITZEL: We'll get into some of that detail now.

Next slide. Regarding the technical assessment, this was mentioned earlier, and the parametric evaluation which was performed by Los Alamos to determine if sump clogging was a credible concern. It was done on a plant-specific basis. There were industry surveys, et cetera, that were done to quantify the insulation locations, et cetera, but it wasn't complete, so estimates had to be made. You couldn't say definitely that was the plant that was out there and the geometry and the location. So it wasn't plant-specific necessarily, but it was based on plant-specific data.

Then when it was completed parametrically, it looked at the evaluation of the head loss versus the insulation, favorable/unfavorable conditions, and then categorized plants, and did come up with a result of quite a few plants for large LOCA were deemed to be very likely to have a problem, and that was the issue you looked at last year.

John, next slide. As I mentioned, more and finer debris can be generated by a high-energy line break.

CHAIRMAN WALLIS: More and finer debris than what, than had you thought before?

MR. ARCHITZEL: In other words, remember

it is going back to USI A-45, I think. I've got the number right here, 46. At the time that issue was stated to be not cost-beneficial to go forward and to backfit on all the plants.

Looking at it now, that was big fiberglass blankets coming up. The guidance at that time, if there had been any, would have been to remove all the fiberglass insulation. It would have been very expensive.

Now with the more and finer debris, it is actually additional information which says you have thin bed effects and things like that. Fiberglass removal, it's not necessarily the solution anyway. There's latent fiber and things like that. You have filtration effects of the fiber that weren't considered at that time. So there is more information now that states there's a reason for examining this issue further. It's not just the issue that exists in 1985, and the solution is potentially different today also.

MR. ROSEN: I thought that one of the most significant pieces of information that came out of that was about the combination of materials that could form on the bed, fibrous and particulate --

MR. ARCHITZEL: Exactly.

MR. ROSEN: -- and the synergy of those kinds of materials in forming debris beds that could create significant pressure drops. I thought that was very significant because, in thinking back to my chemical engineering background, I'm aware that those kinds of conditions are created purposely in certain kinds of chemical engineering unit operations to, in fact, create debris beds that are used to filter other products out of process streams. So it rang very true to me that that kind of formation of a debris bed would, in fact, create a large delta p, if it was appropriately designed.

MR. ARCHITZEL: Well, Dr. Letellier has some slides later that show the effect. When he gets to that point, he will show you the thin bed effect and how it's not monatomic. We've also had some correspondence from PCI and other places that, yes, it is an effect and little amounts of --

MR. ROSEN: A well-known that used in chemical engineering and in operation processes.

MR. ARCHITZEL: Right. The difficulty is they can't remove all the insulation, all the fibrous insulation. You've done away with the problem; you still have a little bit of it that still causes a problem, and the latent fiber can cause a problem.

CHAIRMAN WALLIS: If Davis-Besse had popped in the head, there was insulation up there, wasn't there?

MR. ARCHITZEL: That was mostly RMI, yes.

CHAIRMAN WALLIS: There was insulation up there, and there were also boron crystals and things that, presumably, would have found their way somewhere?

MR. ARCHITZEL: Boron. I think the boron would have dissolved.

CHAIRMAN WALLIS: I wonder if there was any assessment of this problem in association with Davis-Besse?

MR. HOLAHAN: Yes.

CHAIRMAN WALLIS: Did they conclude that there was a potential for blocking the screens there?

MR. HOLAHAN: The issue was looked at by the staff in two contacts, and I presume that the utility has also looked at it.

As part of the reactor oversight process, there's a significance determination process where we look at the risks of what could have happened. Obviously, one of the issues was basically a potential for a medium LOCA. It's a size and type of LOCA which would have required ECCS recirculation. So the potential for some blockage was one of those issues.

Our conclusion at that stage was, because of its location, the lack fibrous insulation, and the fact that it's a pretty long path between that location and getting things to the sump, that it wasn't an important contributor for that one.

Now I must say that we are now, the Office of Research is now going through a second stage where they look at the accident sequence precursor program. I think they will have to look at the latest available information. Since I'm sure that the sequences that they are looking at also involve recirculation, I think they will also look at the subject.

DR. BANERJEE: This technical assessment, was there an experimental base for it?

MR. ARCHITZEL: Many years of experimental basis, a lot of research by Los Alamos.

DR. BANERJEE: So there was an assessment of what breaks up, what doesn't?

MR. ARCHITZEL: Transport, generation, the whole everything, the types of insulation. But I wasn't really planning to go into that here. There was a lot of --

CHAIRMAN WALLIS: They actually experimented? When Los Alamos was here talking to us, they seemed to make a lot of assumptions.

MR. ARCHITZEL: Well, even the Airjet. I mean you could look at the whole history of tests. A lot of it is knowledge-based in the past history, and a lot of it is the BWR testing that was done by industry and Los Alamos also did, especially the transport tests in the pool. They did that on the fiber, and they also did -- I guess I could let Bruce -- you're going to talk to that contribution later, if I can defer that question. There was experimental testing.

I would like to move along because we've got a lot of other topics here. Go back one just a second (referring to viewgraph).

CHAIRMAN WALLIS: The problem is you have to go through the ACRS filter, and it's pretty tortuous.

(Laughter.)

MR. ARCHITZEL: I've got to remember where I am. I didn't mention on this slide other things that were in the technical assessment were an upstream inventory loss is a concern, which had to be modeled. Are there blockage points where pools could form? And, additionally, downstream blockage concerns, and one example we did provide is like HPSI throttle valve.

Then the other thing that was mentioned in the technical assessment was the potential structural effects of having this debris loading and what it could to do the screens from a delta p standpoint.

So, then, repeating myself in the next slide, technical assessment should be conducted to determine whether debris accumulation --

CHAIRMAN WALLIS: Can I ask you now, this fluid is neutral, is it? Does it chemically react with any of this debris?

MR. ARCHITZEL: We have some chemical studies going on currently, and I guess that's -- are you planning to discuss that, too? Okay.

It's borated water. So it's not --

CHAIRMAN WALLIS: Because, you know, so it is acidic, is it?

DR. JAIN: Well, we have to ask plants to study some of these issues. We don't have results yet, but, yes, we would consider different pH values of the water.

CHAIRMAN WALLIS: The concern is, then, if you had an acid acting with, say, a zinc coating or something, producing gases, then the gases make the coating buoyant, and something you thought would sink doesn't sink anymore because it's got gases associated with it. So it moves around.

MR. ROSEN: Well, it's more complicated than that. The plants have baskets in the sumps that contain various chemicals to buffer the pH. So you have to take that into account as well.

CHAIRMAN WALLIS: They are non-acidic?

MR. ROSEN: Right. Sodium bisulfate or some other forms.

DR. LETELLIER: We are looking at that from two perspectives. First, we're looking at the chemicals effects of a pressure drop across an established debris bed; for example, degradation of binders in fiberglass constituents.

And the second aspect, which you have mentioned, we're looking at corrosion products on aluminum and mechanical structures, not from the point of view of buoyancy, as you mentioned, but more from the point of view of solubility and whether or not a flocculent could form and migrate to the sump.

Those tests are ongoing at the present time and will be forthcoming over the course of the next few months.

MR. ARCHITZEL: And, as again mentioned previously, you have agreed with the issue and you have asked to review the guidance as it is being developed, and that's one of the reasons we're here today.

Let's go on to the next slide. Since we're now in this phase, Stage 4, of this management directive process for generic issues, we did develop an action plan to address resolution of this issue. It is the same action plan that we previously looked at the paint issue and the BWR strainer issue. It's an integrated plan, but it's the last phase of that plan.

We do plan, as I mentioned, a Revised Reg. Guide 1.82. The PWR industry is going to provide guidance for plant-specific evaluations, and we're developing a Generic Letter.

Can I have the next slide, John? NRR is contracting with Los Alamos, and they were the contractor for research doing the parametric evaluation. This does provide us continuity in support of GSI and technical support.

CHAIRMAN WALLIS: Will you be relying on them to review the NEI guidance?

MR. ARCHITZEL: Yes, in addition to our review of the guidance; they've been reviewing along with us.

Right now they are completing a set of calculations for a volunteer plant, so that we have a metric to examine what the industry does. So we're getting an analysis done of this volunteer plant that we have good pipe data for and geometric data, and where the insulation is.

Los Alamos is, like I mentioned, commenting on the guidelines. There's some uncertainties remaining. Research did enough work to say it's a credible concern, but they didn't necessarily do enough work to ease the solution of this problem.

So they're helping us in trying to identify where the gaps are in testing. For example, with the BWRs it's fairly easy to see the density of the rust that's in the base of the suppression pool, but what's the density of the particulates in the PWR containment, the concrete dust? We need some information on that. There's other cases. We don't have all the answers.

Los Alamos has also recently, they're in the process of completing a follow-on to the parametric complement to basically assess its operator recovery actions. The parametric didn't have that in there. So now we've got that in there, and it's approximately an order of magnitude increase -- decrease, excuse me -- in the core damage frequency ratio when you factor in these recovery actions that are potentially available to the plants.

That's probably going to recommend that the plants take a look at that and on a plant-specific basis assess what operator recovery actions can be taken. So that's another document that is coming out shortly from Los Alamos for us.

The next slide, John.

CHAIRMAN WALLIS: I'm just trying to think, when maintenance is done, do the people use dust covers and things like that? I mean, is there potential for sheets of material to be there?

MR. ARCHITZEL: Well, all the plants associated with the NPSH evaluations that we did several years ago, we did look at the four material exclusion programs the plants have and the cleanliness programs, and then we had the Paint Generic Letter also, but those programs have all been reviewed.

I guess the comment is just concentration on that, when you're looking at that now, but those activities, like the closeouts, we went to Comanche Peak as part of this assessment. We watched what they do in terms of their closeout and their F&E programs.

I don't know if that's what you're asking.

MR. ROSEN: But containment closeout after the refueling on it?

MR. ARCHITZEL: Right, and that has part of the F&E program, but they have other aspects of it as well.

MR. ROSEN: Well, a lot of that has to do with making sure they don't leave big sheets of plastic in, and I wonder if that was done with the idea of this problem in mind, the fine concrete dust and other more subtle things than big sheets of plastic or --

MR. ARCHITZEL: Well, it's not strictly big sheets of plastic. It's also --

MR. ROSEN: Bags of stuff.

MR. ARCHITZEL: The labels and all that type stuff is all included in there --

MR. ROSEN: Sure.

MR. ARCHITZEL: -- how they are on and whether they're going to become --

MR. ROSEN: Yes, all the standard stuff. You want to make sure that things that are loose in the containment don't, in fact, restrain, they are minimized and tied down, and that sort of thing. But my point is that, and my question is, were they thinking about this particular problem and the research results we have to date?

MR. ARCHITZEL: Well, I think that's more in the Condition Assessment Guidelines, the survey that's being done. That's more going out there and sweeping the tops of the pipes and seeing how much dust, et cetera, you have and trying to quantify that. That's ongoing today. It may not have been complete, you're right.

John, next. This is, just to give a little bit of a highlight. The NEI did have a Sump Performance Task Force formed in 1997. They have been holding regular meetings and conference calls.

But one thing that, since the technical assessment was completely transferred over, that was one of the first stages to see if the industry has an initiative or what's the industry's perspective on that. The very first meeting we did have with them, after we invited them, was the initiative of the six-step program that they've got, including the Condition Assessment Guidelines first, and the second step is really producing the industry evaluation guidelines. Then you get into plant-specific resolutions.

So I just wanted to mention that, when industry does propose a program, we do go and follow the program and endorse it, if we can go along with it.

John, next slide, May 30th. These are a chronology of what we have been doing. I guess we've had a lot of meetings here.

We've had a discussion of the Condition Assessment Guidelines in May. We did discuss -- and Gary's given you some of the particulars -- about the potential interim actions and compensatory measures that can be taken, and our regulatory assessment in July.

The industry workshop was conducted by NEI. We attended and made a presentation there. So industry was sensitive to our concerns at that time and it made sense, too.

In August we did provide comments and feedback on their Guidelines for Condition Assessment and then they addressed our comments and were responsive to them in making a more complete document. In addition, they made changes for what the plants had learned when they did the configuration assessments. We added the HPSI throttle valve blockage issue, as I mentioned.

I want to mention at the October meeting we did have the groundrules document, which just kicked off, and then in December we got another version. I think you all were distributed copies of the groundrules document, at least how they exist right now.

They're kind of high-level documents at this stage. They're nothing like the BWR URG, which is fairly thick, but those are detailed guidelines. So we're into this preliminary stage of outlining what the guidelines look like.

We also did have a discussion with PCI, who's a contractor, an insulation contractor. They sent us a letter, and we discussed the fact that there was a concern about PWRs in general removing all the fibrous insulation.

We had to look at that issue because that's not necessarily the solution to this problem. You can still have a blockage problem even with minimal amounts of insulation in containment. So you have to be careful about the solution.

I guess going on to December 12th, it's just additional -- where I mentioned we did give feedback on the design and testing of openings.

Then the next thing I've got is upcoming. We haven't really evaluated the debris generation guidelines we just got in December. We're still internally looking at those. We're also going to have a meeting at the University of New Mexico and look at some of the hydraulic lab testing facilities.

Let me go on to the next slide, John. Getting off what we've done in the meetings, the schedule and where we're headed, public comment on the Draft Reg. Guide is scheduled right now for February 2003 with the final in September 2003. That Reg. Guide currently is set for guidance for the staff on how to evaluate these issues, and for industry. It's not currently being examined as a backfit, I guess is what I'm saying there. It would be before-fit on any plant that would come in down the line. But we will be using that as guidance, an acceptable method to address this issue, when we look at it.

The Draft Generic Letter we expect to get out this quarter. This is a pre-decisional document. So we haven't released it to industry yet. We've given it to you, but realize that the CRGR hasn't reviewed it yet and given us any comments.

The Generic Letter is currently scheduled for the summer 2003, and NEI is still planning in fall of 2003 for the industry evaluation guidelines.

My last slide, basically, is just to say, once we've got all the Generic Guidelines out and in place, this issue would transfer over from an action plan issue -- I don't know if you really care. It's going to be a multi-plan action that we follow with individual PM closure. Then, as Gary mentioned, we'll do audits, inspections, and review of the responses. That's still to be developed.

At this point I would like to turn it over to John Lehning in order to address the specifics of the Generic Letter.

MR. LEHNING: Okay. Again, this is John Lehning. I'm going to go over the Proposed Generic Letter concerning potential impact of debris blockage on emergency recirculation at PWRs. Again, like Ralph said, it is pre-decisional and pending management approval and CRGR review. Some of the information in the presentation I'm going to give is tentative right now.

Next slide. The purpose of this slide is just to explain kind of the package that we gave ACRS members. This is the package that we are going to pass along to CRGR. The only attachment I'm going to go over in detail is the Generic Letter in this presentation, but I'll just explain what the other attachments are.

Attachment 2, basically, explains the

basis for the Generic Letter, to pursue a compliance backfit, which is what this Generic Letter requests action in that vein. You have to meet two criteria; that is, a noncompliance has to exist and then it has to be a significant issue. So Attachment 2 basically justifies those two criteria and why those criteria are met by this issue.

Attachments 3 and 4 just provide further information about the cost/benefit and the significance of the issue. Attachments 3 and 4 were already presented to the ACRS in September 2001.

So going on to the purposes of the Generic Letter, the first purpose is simply to inform PWR licensees of research that the NRC has sponsored that shows that some blockage with debris in a post-accident condition is credible for PWRs. What I guess that bullet is referring to mainly is the parametric study which was the culmination of researchers' efforts showing that issue was credible across the industry.

The second purpose of the Generic Letter was to also examine three additional debris blockage or post-accident debris blockage effects that were also recognized as significant by the GSI-191 effort, and Ralph named those. But, again, what they are is the potential deformation of the sump screen by the debris bed, causing a lot of force.

You may not have adequate structural strength for the screen. You may also hold up water in containment volumes, such as like a refueling cavity, when the drains block with debris, and also the downstream blockage issue, if you have debris infiltrating with the sump screen, if the clearance is not adequately sized for what it's trying to protect.

The third purpose is to request the action. Basically, we want the licensees, PWR licensees, to act on the concerns that we have and then, if necessary, to also assess whether they need to take, in turn, compensatory measures that Ralph discussed, and then also corrective actions.

The final purpose is to get information back from PWR licensees concerning the actions we requested and whether they are doing them or not.

CHAIRMAN WALLIS: Looking at these bullets, and having read your draft, it seems more like the kind of thing that this is what the polite British understatement would be like, sort of please look at this and do whatever is appropriate. Usually, the NRC has been more specific.

MR. LEHNING: I'm not sure, is that for

all the actions that we're requesting because --

CHAIRMAN WALLIS: It seemed to be very much the general level of look at this and, if it's a problem, fix it and take appropriate action. It's very, very general, and it's a trusting, you know: You're good a guy and everything's going to be all right.

MR. LEHNING: It's kind of -- I don't want to put it too much in that sense. I mean the problem was with the parametric study we knew it was an industrywide problem, but we don't have information about specific plants that we can say we know that you have a problem with real certainty.

CHAIRMAN WALLIS: It seems to me there's a great opportunity for different plants to have quite specific problems which are different and for you to have difficulties of finding them or accessing them.

MR. LEHNING: I kind of would agree with you, and I think one of the reasons why we have kind of a detailed information request is so that we can evaluate what the responses of the plants are and to determine that they need of further review, that we would then take that further action which would be triggered.

MR. ARCHITZEL: But I guess maybe the

contrast would be the bulletin situation where the boilers would have had the events and where we did issue specific, "Go do it; no questions asked." It was still compliance backfit at that time, but it was a more immediate safety issue perceived. So we would go at a little bit more immediate response and harder response.

This is more, this issue was visited once. It was said it's not cost/beneficial. We've got some things that shifted, but we're not quite as harsh as we were with a bulletin action, say.

MR. LEHNING: And just the other point I wanted to make is that a generic communication can only request action; it can't require an action, too. So that's why it's kind of saying "request," "We request you do this." I mean that's the strongest kind of language that we could --

CHAIRMAN WALLIS: What happens if they do nothing?

MR. LEHNING: Well, then, we have to, I guess, issue like a plant-specific order or something like that, if we determined that a problem was there and that the licensee was not willing to do anything about it. So that would be an additional step of escalation, and we don't anticipate that, but if it happens, then we could take those steps.

CHAIRMAN WALLIS: But if they don't tell you the plant-specific information, you may not know whether there's a potential problem or not.

MR. LEHNING: Regulations require that licensees inform us, to the best of their knowledge, as to these things. So I think we have to trust somewhat.

MR. ARCHITZEL: But that's part of that verification stage. We do have audits. We do have the inspections that we currently are envisioning. So we would have at least an audit review of that, and plus a hundred percent review of the responses by the project managers as a minimum.

MR. LEITCH: If I were a PWR licensee today facing a major outage for steam generator replacement, reactor vessel head replacement -- a number of them are facing lengthy outages -- would I know today what needed to do? I'm a little confused. You talked about some documents that are pre-decisional. Would a licensee know likely what they were going to expect or could make some decisions at risk perhaps?

MR. LEHNING: I mean the total, I mean everything is not specifically defined right now, but if you look at like what Davis-Besse did, they already put in a new sump screen, and we haven't evaluated it and approved it at this point, but they have done that, and so has Diablo Canyon. All the BWRs, they have methodology that they use, too.

So there are parallels that, if a plant wanted to do something now, I think that there's enough information out there that they could probably do something that would satisfy our expectation. Certainly, they might not have it to a fine point. They might have to go a little bit more conservative than they wanted to, but they probably could do something now, if they chose.

DR. BANERJEE: But what did they do, just make a bigger screen, or what is the main difference between this and the old screen?

MR. LEHNING: At Davis-Besse and Diablo Canyon, I think that was the main thrust of what they did, was increase by ten- or a hundred-fold the screen area that they had before. That was one of the main things. They might have done some other things, like with the coatings, at Davis-Besse and other things.

MR. ROSEN: But this is a more complicated answer than that. I think it's fair to say you have to look at the strainer geometries and the way, especially with thin bed effect, you may have an awfully thin bed and still get it blocked fairly easily if it's flat. So you have to have crevices and things like that.

CHAIRMAN WALLIS: What is this thin bed effect?

MR. ARCHITZEL: What?

CHAIRMAN WALLIS: What is the thin bed effect?

MR. ARCHITZEL: I'm sorry?

CHAIRMAN WALLIS: You said, a thin bed effect. I saw it on the previous slide.

MR. ARCHITZEL: Yes, the thin bed effect is, say you have a quite fibrous insulation, or whatever fiber is in the containment, say it's the anti-sea clothing, or whatever, it gets transported --

CHAIRMAN WALLIS: It gets there first, and then it filters out the particulates?

MR. ARCHITZEL: Right, exactly. So in order to handle something like that, sometimes you need -- the BWRs did a lot of testing on those strainers, and they have a lot of carrying capacity. So it's not just an increase of the surface area is necessarily the solution, I guess is what I'm -- the stacked disk strainer and all those type things weren't simple strainer designs or filter designs.

MR. ROSEN: Or filter cycles, Graham, where you actually precoat the filter with a filtering medium like that. The original filtering medium may be just a stainless steel screen, and flow in through it fibrous material. Then you shut the fibrous material flow off, retaining the delta p, and then you turn on the process stream, which may have sand or something else in it, which comes out quite nicely on a thin bed.

CHAIRMAN WALLIS: Well, this is in a chemical plant.

MR. ROSEN: Yes.

CHAIRMAN WALLIS: I understand that. I just don't know --

MR. ROSEN: Okay, well, this is mimicking a chemical plant, is what they're saying.

CHAIRMAN WALLIS: No, it's just that I didn't know what you meant by thin bed.

MR. ROSEN: Yes.

CHAIRMAN WALLIS: I understand the phenomena.

MR. ROSEN: Sorry.

MR. ARCHITZEL: I guess we're ready to go to the next slide.

DR. RANSOM: Do you expect to get an assessment of what the configurations of the sumps, and can you generally categorize them as what types of sumps they have and whether they incorporate things like dams to trap, you know, the dense debris and lead to some separation?

MR. LEHNING: We're not expecting, I don't think, a detailed response as to all the details that the licensees get when they do the walkdown, but we do have a lot of information already in relation to what size of sump screen that they have and whether it's a vertical or a horizontal sump, and whether there are curbs around the sump that would inhibit transported debris there. So we have some information already.

DR. RANSOM: What kind of delta p they could withstand, I guess?

MR. LEHNING: I don't know if we have exactly what structural reinforcement strength that they have, but we know what NPSH margin that the pumps and we can kind of have some idea about what type of NPSH drop across the screen --

MR. ARCHITZEL: But the difficulty with that question is the previous criteria, which we haven't backfit. The 50 percent clean, you could say 50 percent blocked, 50 percent clean. If you've got a 50 percent clean opening, it's a lot different than a uniform bed with a filter buildup on it --

MR. LEHNING: Sure.

MR. ARCHITZEL: -- in terms of differential pressure.

MR. LEHNING: Right, much lower.

DR. RANSOM: Do any of these incorporate active trash racks or any attempt to clear debris from the entrance?

MR. LEHNING: Currently, none of the plants have that.

MR. ARCHITZEL: Well, there's some back-flush capability. I think it's maybe 10 percent of the plants.

DR. RANSOM: They do?

MR. ARCHITZEL: There are some that have back-flush.

DR. RANSOM: You mean the back-flush that actually actuates during the --

MR. ARCHITZEL: Manual operator action back-flush, but there are not many. There are some plants with back-flush.

DR. RANSOM: Well, most plants actually use some kind of trash removal at the condenser inlet screens, and there's a fair amount of technology from that, I would think, of how to remove large amounts of trash, if you've got it in --

MR. LEHNING: Yes, I don't think we mean to exclude that as a solution. I mean, we've focused on the passive kind of solution because that's what the BWRs, they mainly did, because it was the simplest system would be the most reliable system, and there would be less to worry about and do surveillances on. But if a licensee chose to use an active solution to this problem, I mean we would review that.

CHAIRMAN WALLIS: I think you would have things like fences to catch the big debris before it gets to the screen.

MR. ARCHITZEL: Right.

CHAIRMAN WALLIS: Once it gets to the screen, it's a problem because it makes this thin bed, but if it lodges against the fence --

MR. ARCHITZEL: That was one of the features of Davis-Besse. They sort of had fences quite remote from the new sump they put in to capture some it out there. As far as active strainer goes, some, like the Swedish plant, did put in some like active wing strainer, where you just turn the pump off and some drops, a combination of active/passive, those kinds of things.

CHAIRMAN WALLIS: No pressure drop across it or anything. At least it's there and catches the debris. Okay.

DR. RANSOM: In fact, you would think they might even use a vortex separation device, just like you have in household vacuum cleaners these days.

MR. LEITCH: I seem to recall the last time we discussed this issue that we had a big pack of paper that had like similar data from each and every power plant with the size of the screens and the flow velocities, and that was probably it. And I thought it had broken down the plants as to susceptibility; that is, some --

MR. LEHNING: Exactly.

MR. LEITCH: -- looked okay as was, and others looked like they had a serious issue. Is the Generic Letter going to address that somehow and say that Plants A, B, and C appear to be okay the way they are; Plants D, E, and F need to do this and such?

MR. LEHNING: The Generic Letter doesn't go into that kind of detail because the parametric study wasn't really intended to show whether that model, whatever model, whatever plant it corresponded to, it wasn't intended to have that kind of detail and a definitive association with a plant.

So the way that the Generic Letter treated the parametric study was just to show that industrywide we had a credible problem because some of the things in the parametric study were not modeled in enough detail, like the geometric location of the insulation and transportation paths, and like that, weren't modeled to the extent that we felt confident enough to break down classes and categories in that respect.

DR. RANSOM: Was this report put together by NRR?

MR. ARCHITZEL: No, this was the results of the technical evaluation phase that we mentioned. This was the Foundation for Research transferring this issue to NRR. This was the culmination of technical, if you want to -- but this was the --

DR. RANSOM: Well, it sounds like you already have some data on how many plants may be susceptible and ones that will not, I guess.

MR. DORMAN: This is Dan Dorman from Research.

In that technical assessment study, there was a substantial amount of plant-specific information gathered from the surveys that had the sump screen sizes, and there was an attempt to categorize the different types, the configurations of the sump screens, and so on.

But for a number of issues in the cases that were defined, they were careful to define them as cases and not -- because for a number of issues, we were using generic information developed from a couple of example plants that we had more detailed information on in terms of the piping locations and debris generation, and so on.

So, for that reason, the conclusion of the technical assessment was not laid out in terms of these plants are more likely to have a problem than those plants. It was dealt with at a case level, and the conclusion of that was that it was a credible issue and, therefore, given all these plant-specific variables, it's appropriate that plant-specific analyses be performed to determine the susceptibility on a plant-specific basis. The work that's going forward here is to provide the guidance to enable the licensees to make those plant-specific assessments.

CHAIRMAN WALLIS: I'm trying to think about the timing. Your letter is going to request an answer in 90 days?

MR. LEHNING: An initial response, yes.

CHAIRMAN WALLIS: This is before NEI

guidance really comes out, isn't it?

MR. LEHNING: Yes, that could be the case or it might be after; the response may be after, depending on the final --

CHAIRMAN WALLIS: You may get an amazing array of different approaches?

MR. LEHNING: We don't anticipate that. I mean, I think the reason the NEI put that guidance together was because the industry believed that most of the plants were going to use it, but there may be plants that decide that they're not going to use it. We may have some different approaches.

CHAIRMAN WALLIS: But I don't think they've put together the guidance yet. The guidance I've seen is only to do with walking around looking for where the debris might come from. That's quite different from figuring out what happens to it in an accident.

MR. LEHNING: Correct, and the Generic Letter is planned to be issued, I think, the final version of it in the summer of 2003. So NEI is planning to publish their final industry guidance, I think, in September. So I think 90 days after we issue the final Generic Letter, we request a response from licensees telling us what they plan to do, if they plan to use NEI guidance at that time or if they plan to use a different methodology.

So they'll have time, I mean, even to look at it and determine if they want to use it or if they want to do something else by that time.

CHAIRMAN WALLIS: Does all this depend on NEI getting their guidance out on time?

MR. LEHNING: We could end up restructuring the Generic Letter somehow. I mean, we think that right now it looks like the guidance is not, you know, way off schedule or anything. As far as I've heard, it's coming out at that time.

DR. BANERJEE: So this stuff is generated when you have a big break, or whatever, and get sort of a shockwave which moves and breaks stuff off, and then it erodes the stuff under it? Is that what happens?

MR. LEHNING: That's part of it. I think --

DR. BANERJEE: What is the physical stuff going on here?

MR. LEHNING: I was going to go over that in a little bit of detail.

DR. BANERJEE: Okay. You are?

MR. LEHNING: But Dr. Letellier is going

to go over it in much more detail.

DR. BANERJEE: I think that's sort of important because NEI has sort of proposed somewhere that these things will be leak-before-break or something, right? So they eliminate the shockwave, I take it? Is that the intention?

MR. SNODDERLY: Excuse me, John. This is Mike Snodderly from the ACRS staff.

To get to the issue that Sanjoy was talking about, I think it's important that we try to stay on schedule and get to the Reg. Guide around 2:15. As Graham pointed out, the focus of this presentation or this meeting is on analyses that may be required as part of the Generic Letter and how such analyses may be conducted.

So what I would like to suggest is, could we perhaps go to your slide on the required actions?

CHAIRMAN WALLIS: Actually, you don't have many slides left, do you?

MR. SNODDERLY: Yes, I think it's important, yes, to --

CHAIRMAN WALLIS: You're going to rush or run through the slides quickly?

MR. SNODDERLY: Yes, cover all your material quickly, but try to make sure we get to the requested actions, what's being requested.

CHAIRMAN WALLIS: Yes, and I think also the phenomenologies of interest because that's part of this question.

MR. SNODDERLY: Okay, because I think isn't the phenomenology addressed in the Reg. Guide?

MR. LEHNING: It will be covered. I think Bruce will cover that in enough detail.

MR. SNODDERLY: Okay.

MR. LEHNING: Maybe I'll just flash the slide up there for a moment.

The background, I think Ralph covered that pretty much, so we can skip that and go straight to the phenomenology.

MR. SNODDERLY: Thank you.

MR. LEHNING: Just really quickly, the primary means, I think we are talking about the shockwave, but also jet impingement of the pressurized fluid as it is expanding out of the pipe break.

DR. BANERJEE: So that's an erosion-type phenomenon?

MR. LEHNING: Yes, it will, yes, uh-huh.

DR. BANERJEE: It's sort of a droplet erosion or a steam erosion or something?

MR. LEHNING: Yes, I'll let Bruce go into a lot more of the detail. Then, also, you have the containment global conditions could cause coating disbarment and stuff like that.

Ralph already went into the kind of resident dust floating that coats all these surfaces and why that's a concern for plants, especially with a small screen, that this could have enough fiber, even there, and the debris transport and accumulation I think Bruce will cover as well, so go straight to it.

The concerns that are addressed in the Generic Letter, sump screen debris blockage is one of the main concerns, and what the specific parametric study focused on was just the loss of the NPSH margin for the emergency core cooling system and containment spray system pumps. So it compared what the required pump NPSH was and then looked at what was available, based on the head of water and other conditions that are factored in, and then compared that to what kind of NPSH loss or pressure drop would occur across the debris bed, and whether that would exceed the NPSH margin that was available.

They found that that was a credible concern. Kind of the reason it was is because all these plants were designed with a 50 percent blockage, and it's a lot lower head loss if you see the screen is half clean.

But then, in addition to that issue, you also had the deformation issue of the screen, too. When you have this high pressure drop across it, the screen bears all that load, and if it's not adequately reinforced, it could deform. At a BWR, Perry, we saw a very thin bed of debris form and cause deformation of that strainer. And, of course --

CHAIRMAN WALLIS: It's strange that you wouldn't design your screen to take the maximum suction that the pump could put on it.

MR. ARCHITZEL: But they are assumed to be half clean by design. Yes, that was the design assumption, was 50 percent blockage.

CHAIRMAN WALLIS: Fifty percent sounds like just somebody guessing between zero and a hundred.

MR. ARCHITZEL: That was, but it was a very -- it is in a sufficient area not to have a high differential pressure.

MR. LEHNING: The 50 percent blockage I think was based on the pieces of debris being a very large size, and then you couldn't have all these -- that's what the concern was with this fine debris, that you would block a lot more of the surface area with the debris.

MR. ARCHITZEL: I would like to make it very clear that that assumption was disowned in 1985, and we no longer -- it was recognized as not being a good assumption. It was stated to industry. It's never been the NRC position since even before, you know, around that timeframe, and the industry has been informed of that. Whether they've taken any action or not was sort of left a little bit somewhat up to industry at that time.

MR. LEHNING: And, again, I mean the issue with the deformation, the damage to the screen, is that you could have a lot of debris ingesting if you have a breakthrough of the screen.

Again, the upstream blockage issue of trapping water in like a refueling cavity or compartment drains, or something like that, if they become blocked with debris, you could reduce the NPSH that you have available to the pump that you're relying on to ensure that you have these pumps operable.

Then the downstream issue, if the screen is not adequately sized, again, you could block areas like containment spray nozzles or HPSI throttle valve or fuel assembly in the debris screens. Some of these sump screens are not adequately sized for these small flow restrictions from downstream.

The next slide, the requested actions of the Generic Letter: The first one is to perform an evaluation that's based on the concerns that we identified, all four of the concerns requesting that licensees take a look at and determine whether they have a problem with that on a mechanistic basis, rather than just making a 50 percent blockage assumption.

Then the second requested action has to do with interim compensatory measures. Basically, before the detailed evaluation is performed, we are asking licensees, when they get the letter, to kind of take a look at whether or not they need to do things ahead of that, if they have a bad condition.

Part of the recommendation that we had to that was that, if licensees are non-conservatively relying upon the 50 percent blockage criteria, they may need to do something ahead of time.

So then the third one is obviously to implement any plant modifications that are necessary to return to compliance, if your evaluation identifies you're not in compliance.

Next slide. Then just the basis for the action request: Like I said before, we are requesting action, and we're requesting action on a compliance basis, so it's considered a compliance backfit. Again, what you need to show is that a non-compliance situation exists and that it's a significant issue, so that the non-compliance that we're saying exists with the 10 CFR 50.46, specifically the long-term core cooling requirement that's there, and also plants rely on their licensing basis on the containment spray system for safety-related purposes and the GDCs as well.

So then the value, again, goes back to the attachments to the CRGR package, Attachment 2, 3, and 4, that show that this is a significant enough issue that we should pursue it.

Next slide, please. Getting on into the information that we are requesting, we are using 10 CFR 50.54(f) to require a written response from licensees, so that we have assurance that they will get at least a response to the letter. There's two parts to the response.

The first part is basically asking licensees about the plan for doing things, plans for doing the walkdown of containment, to identify debris sources, the plans for performing the evaluation we are requesting, and also the plans for implementing interim compensatory measures before doing the detailed evaluation. Again, that first information request would be, I think, 90 days after receipt of the letter.

The second part to the information request would come after the licensee had completed the evaluation. At that point we would ask for more detail about the methodology that was used, the result of the evaluation, rules for performing modifications, the necessity of continuing with interim compensatory measures until the modification, all modifications are complete that are necessary, and then also future controls to ensure that, if you bring in a potential debris source, that you're evaluating it and that it's not going to cause a problem for your ECCS operability.

Next slide, please. This has to do with the coordination with industry. As you have heard already, the NEI I think is under that umbrella. The industry is coming up with the guidance details that are needed for the licensees, PWR licensees, to perform the evaluation that we are requesting in the Generic Letter.

The first part of that, the first step or first part of that guidance was the containment walkdown in the Condition Assessment Guidelines that NEI created to allow licensees to take an inventory of the debris, and we worked together pretty cooperatively on that.

NEI addressed the staff's comments. They, basically, presented to us in a public meeting the guidance that they had, and we gave comments back in that forum.

As far as the evaluation methodology, we don't know too much about that right now. We have seen the groundrules, and there may be some issues that challenge us on that, but we still have a long way to go. Hopefully, we can come to an agreement, an accord, on what the proper course of action is on that. So still it's too early to decide whether or not we can fully endorse those guidelines.

MR. ARCHITZEL: But that caveat was also expressed in the Generic Letter Draft, that if it was recognized that the guidelines we drafted -- we may need to revisit or supplement the Generic Letter if that situation existed and we couldn't reach agreement.

MR. LEHNING: Yes, that was my last

bullet, but Ralph jumped in and preempted me on that one. But, yes.

So I guess that concluded the presentation I was going to make. So I guess B.P. will be the next speaker, some research. B. P. Jain will talk about the Draft Regulatory Guide, DG-1107.

DR. JAIN: Good afternoon. My name is B.P. Jain from RES, the Research Division of Technology.

Ralph and John have gone over the GSI-191 issue and the resolution process. The Generic Letter and Draft Guide are two complements of that process. I'm going to talk about the Draft Guide 1107.

We plan to issue this Reg. Guide for public comments, and the staff is seeking your concurrence for releasing the Draft for public comments.

This Draft Guide provides methods and approaches that are acceptable to the staff. Bruce, of Los Alamos, will be describing some of these approaches in more detail.

Approaches described here are not necessarily the only approach. The licensee can submit alternate approaches for staff's review.

With this, I will go over my presentation first and then Bruce will follow.

Next. In this presentation I will describe the process we use in issuing the guidance and provide a background on the evolution of the Reg. Guide from Rev. 0 to Rev. 3. We'll also include the Reg. positions that are acceptable, the contribution of GSI-191 to such program, and what are our plans and schedule to issue the Reg. Guide, and, finally, the conclusions.

Next, please. The process begins, of course, with preparing the draft guidance and then brief the ACRS, as I'm doing today, and upon your concurrence, we'll issue the Draft Guide for public comments. Then we'll address all public comments and brief CRGR and the ACRS again. Then, after resolving all comments, we will issue the final Reg. Guide as Revision 3.

CHAIRMAN WALLIS: So this Draft DG-1107 is going to eventually become 1.82.

DR. JAIN: 1.82, Rev. 3.

CHAIRMAN WALLIS: It just has a temporary name?

DR. JAIN: Well, DG-1107 is a temporary name. It's a Draft Guide. So once it goes through the process, it will come out as 1.82, Rev. 3.

Next, please. Here I have provided some background and evolution, and Ralph and John have touched upon part of them.

Rev. 0 of the Reg. Guide 1.82 was issued back in June 1974. That included the provision of NPSH calculation based on 50 percent blockage. That's the initial design.

Well, then in November 1985, when USI A-43 was recognized, as part of resolution of that, Revision 1 was prepared and issued. However, Revision 1, in accordance with Generic Letter 85-22, the staff at that time concluded that Rev. 1 of the Reg. Guide would not apply to any plant then licensed to operate or under construction, and then it would be limited to conduct 10 CFR 50.59 reviews dealing with change or modification to thermal insulation.

CHAIRMAN WALLIS: I don't quite understand this. The NRC issued a Reg. Guide which didn't apply to any plant?

MR. ARCHITZEL: The reg. analysis for that was for forward-fit. So like the ABWR and the System 80-Plus, you know, the plants designed six months after that stage had to design mechanistically for the transport --

CHAIRMAN WALLIS: Just legally you

couldn't make it stick?

MR. ARCHITZEL: No, we could have made it stick at that time. We have reg. analysis that was quite extensive and it went into the cost/benefits. Most of the issue at that time was related to vortex suppression and things like that, the third issue. Those were put to bed with saying maybe the issue is not quite as bad as they initially thought it was.

The issue -- and it was considered a PWR issue -- was considered worse than they initially thought was this debris blockage issue and the sump blockage issue. Recognizing the mistake of the assumption in the initial Reg. Guide, providing industry the information, and said, "We can't make it on a cost/benefit."

You know, containments were robust. Even if you had ECCS failure, you're not going to have the cost/benefits with millions of dollars to replace all this fiberglass insulation. The decision was made not to backfit, but to let them do it forward-fit through modifications and considering the 50.59 process.

DR. JAIN: Subsequent to Revision 1, the events of the nineties, namely, the Barsebeck that resulted in the blockage of strainer, prompted a re-reviewofthe blockage issue for boiling water reactors.

Based on the research program and BWRs, guidance was developed for BWRs and Revision 2 of the Reg. Guide was issued in 1996.

NRC Bulletin 96-03 requested the licensee to implement measures to ensure ECCS functions following LOCA is ensured.

Subsequently, for PWRs, the GSI-191 research program was initiated. That confirmed the class of ECCS NPSH margin due to sump clogging issue was a credible concern.

Staff presented the results to the ACRS, and the staff was directed --

CHAIRMAN WALLIS: Let me understand the potential seriousness of this. If you lose NPSH, you can't recycle the water from the sump; then you can't cool the plant long term and, therefore, you lose the core? Is that right?

DR. JAIN: I didn't get your question.

CHAIRMAN WALLIS: This is a potential loss of core actually?

DR. JAIN: It's a potential, yes.

MR. ARCHITZEL: Yes. There's other things -- you can refilter.

CHAIRMAN WALLIS: You might find other ways to cool it, right.

MR. ARCHITZEL: To get water in, you can spray, you know. Then you can maybe maintain containment integrity even if you failed the core and keep it inside the containment. That was all part of that analysis.

CHAIRMAN WALLIS: But it wouldn't, the long-term cooling as designed, wouldn't function anymore?

MR. ARCHITZEL: Or you start and stop pumps.

CHAIRMAN WALLIS: That's right.

MR. ARCHITZEL: It wouldn't be as designed.

DR. JAIN: So as part of the research, we are issuing the Draft Reg. Guide 1107, and that's where we are.

DR. BANERJEE: Was it credible to have both trains fail like that and blocked and everything?

MR. ARCHITZEL: Bruce?

DR. LETELLIER: That was included in the risk assessment. I'm not personally familiar with that study, but it was factored in.

DR. BANERJEE: They are geometrically separated, aren't they, at the sumps?

DR. LETELLIER: No, not always. They are

co-located. In most plants they are physically separated by a baffle or a separation, but in many instances they are in the same location of the plant and subjected to the same transport fractions.

DR. BANERJEE: I see. Good.

DR. JAIN: Next, please. On this slide I'll discuss what has changed from Revision 2 to Revision 3 in the current version. In this revision primarily the BWR sections have been revised to enhance the Debris Blockage Evaluation Guidance. That had not been the way since Rev. 1 that was issued in 1985.

The Guidance is consistent with the BWR guidance in Revision 2 and the insights gained from the GSI-191 research program. Some minor changes which are editorial in nature have also been made to existing BWR sections to reflect the staff's position in safety evaluation on BWR owners' response to Bulletin 96-03.

This revision also integrates previously-provided guidance in Reg. Guide 1.1 titled, "Net Positive Suction Head for ECC and Containment Heat Removal Pumps" for completeness. This Reg. Guide 1.1 will be deleted after Revision 3 of the Reg. Guide 1.82 is issued.

Next, please. Now I will provide some highlights of insights from the GSI-191 research program. Bruce will go over more details of those analytical techniques. First, I'll provide insights for debris source and generation

Based on the industry survey of 1999, it was determined that the majority of the plants have three types of insulation: fibrous, RMI, and Calcium-Silicate. Research also indicated that the amount of debris that is generated largely depends upon the type of insulation material, primarily because you have different destruction pressure thresholds and, therefore, the zones of destructions.

It also depends approximately on orientation of the insulation relative to the break location and how the insulation is installed. The damage pressure could vary from 10 psi to 150 psi, depending on how insulation is installed.

An acceptable approach for estimating debris is provided in NUREG/CR-6224 and in BWR Owners' Resolution Guidance and the staff safety evaluation of BWR Owners' Response to Bulletin 96-03.

Now Bruce is going to discuss in more detail about the zone of influence, the destruction pressure, and other considerations which go into --

MR. ROSEN: I want to ask you a question about this destruction pressure threshold.

DR. JAIN: Right.

MR. ROSEN: My mental model of this is more of an erosion kind of phenomena, where a jet impingement from a break basically destroys the insulation that's in with the zone of influence. That model doesn't relate very well to a general pressure increase and a destruction pressure threshold.

So can you help me understand what destruction pressure threshold means?

DR. LETELLIER: We'll show some illustrations of the damage zone a little bit later, but I think you can imagine that, beyond a certain distance from the jet, the pressure would not be great enough to cause erosion. So that represents the threshold for destruction.

Within that radius, there are various size distribution of debris that's generated, from the very fine particulates to the fragments and the partial jacketing material.

MR. ROSEN: But throughout the containment, the pressure is going to go up "X" number of psi, and outside, a long way from the zone of influence.

DR. LETELLIER: That's true. We've focused on the pressure contours within a free-fueled jet to basically identify those erosion mechanisms that are important, and we're ignoring the quasi-static pressure increase across the containment.

CHAIRMAN WALLIS: I would think you would be interested in momentum flux. Isn't that it, rather than pressure? I mean, if I control a crowd with a firehose -- you know, it's not the pressure of the jet; it's the momentum of the jet. It may be converted to pressure when it hits something, but --

DR. LETELLIER: That's an important observation. There's a lot of speculation about the exact physical mechanisms of debris generation and insulation degradation, but the fact is that most of our information is based on test data, where pressures were the easiest thing to be measured.

For example, a typical test series would place a debris blanket of a given composition and size at different distances from the orifice.

DR. RANSOM: What pressure do you mean now, the static driving pressure of the jet, which is the same virtually as the dynamic pressure?

DR. LETELLIER: We're talking about the stagnation pressure on the face of the blanket.

DR. RANSOM: Yes, okay. So they would have some momentum effects.

CHAIRMAN WALLIS: It takes some time. I just yesterday washed off a pile of accumulation under my car, and it was amazing how long it took this jet to wash off the stuff. There was an erosion phenomenon. You would wash it off and then some more comes off. So just time must come into it, too, doesn't it?

MR. ROSEN: I think this question of what actually is disturbing the insulation material, what physical phenomena are we talking about, is very important because it gets into how much debris is going to be generated. It's a crucial parameter. I would like to hear as much as you can say about that.

CHAIRMAN WALLIS: We're going to hear about that, aren't we?

DR. LETELLIER: I hope so. Is it my turn?

CHAIRMAN WALLIS: Well, later on you can --

DR. JAIN: Later on, we'll cover that, I suspect, in more detail.

CHAIRMAN WALLIS: Keep us in suspense.

DR. BANERJEE: Just to recap, there's no time lapse momentum flux. That's probably what happens that's involved here. It's just sort of a threshold without a time involved?

DR. LETELLIER: Of course, experimental data do involve an exposure time, a blowdown time, and that has been taken into consideration when we examined the differences between the test conditions and the actual plant blowdown conditions. So those effects that you are mentioning have been incorporated in our estimates of damage threshold, which is reported in terms of destruction pressure, and also in our estimates of the debris volume, in other words, the extent of that zone of influence.

DR. BANERJEE: So will you clarify for us why leak-before-break criteria may reduce the damage of the debris?

DR. JAIN: I guess we will cover that later. Somebody knows, right?

MR. ARCHITZEL: I'm not sure we're ready to talk leak-before-break now, but if you take the size of the pipe and then the sphere of influence related to that with the initial blowdown, the momentum, as you say, obviously, if you don't have the large pipes there for the break, the smaller pipe you have, the smaller zone of influence there. Is that the question or what?

DR. BANERJEE: Well, I don't know. I mean, if you have a leak-before-break but the pipe still breaks, does it make any difference?

MR. ARCHITZEL: Well, I'm not sure. There's a question -- leak-before-break you might take it all the way out down to no effect at all or you could say there's a residual effect of a crackage leak. I'm not sure. We currently haven't accepted leak-before-break, so that's not really on the table for us.

DR. KRESS: Generally, a leak-before-break takes that pipe out of consideration of this initiating event. Because you see the leak, you are going to stop and fix it.

CHAIRMAN WALLIS: I think this is a different issue which we have to face sometime today, but I'm not sure that it's the right time now.

DR. BANERJEE: Okay. I got the wrong end of the stick. I think it was really, if you had a break that developed gradually, is there a difference from a break that occurred suddenly?

CHAIRMAN WALLIS: No, a leak-before-break is a kind of --

DR. BANERJEE: Just a measure to take it out?

CHAIRMAN WALLIS: A way of disregarding certain things on the basis of not being very likely.

DR. BANERJEE: So it's not the shockwave, but --

CHAIRMAN WALLIS: The reason for it is quite different from the rationale associated with this debris.

MR. ARCHITZEL: But our guidance, a leak-before-break does have a couple of pressurization schemes. If you're going to talk about pressurization of a room and a leak-before-break pipe, you still have to take the diameter of the pipe and open it over three seconds instead of instantaneously, but that's for room pressurization. I'm not sure that would apply, even if we went there.

Then you're also dealing with leakage cracks, which leakage cracks are like the diameter of the pipe and the thickness of the pipe, which is a significant break, more than a leak-before-break, the ten gpm, but the groundrules might be, or I guess what industry has asked for is, to consider leak-before-break. Then you have no effects and you take it to zero.

But we consider it doubling the guillotine. That's the leak we're dealing with for

ECCS performance.

DR. JAIN: Go to the next one?

CHAIRMAN WALLIS: Yes, please.

DR. JAIN: Here are some more of these insights from the debris transport tests performed as part of the GSI-191 program. The details of these are provided in NUREG-6773.

Some of the highlights are that substantially more debris is transported to sump relatively soon after the switchover to recirculation.

CHAIRMAN WALLIS: Do you mean more debris than was previously thought? Is that what you mean by more debris?

DR. JAIN: In other words, compare the total debris; you've got 60-70 percent of the debris gets into the pool in the first -- right after switchover, if you're talking about like two or three hours' timeframe.

The second bullet says that --

MR. ROSEN: Did you answer Dr. Wallis' question? I didn't understand it. He said, "More debris than what?" He has used the word --

CHAIRMAN WALLIS: More than previously thought or what?

DR. JAIN: Well, "more" meaning

substantial percentage of the total debris, like --

CHAIRMAN WALLIS: Okay, that means -- so "more" doesn't really belong there. You mean substantial percentage of the debris is --

DR. JAIN: Percentage is the --

MR. ROSEN: Whereas, before that was not what you thought?

DR. JAIN: Right.

MR. ARCHITZEL: Right. It's more debris soon after switchover as compared to the amount of debris that is moved over a long period after the switchover. Perhaps a better way to say that would be the majority of the debris that gets to the screen is being transported early after switchover. Is that right?

CHAIRMAN WALLIS: The majority of the debris.

MR. ARCHITZEL: Majority, I'm not sure majority is right.

CHAIRMAN WALLIS: It's probably substantial.

MR. ARCHITZEL: I'm looking to Bruce or B.P. to clarify that, but more is relative to the soon-after-switchover as opposed to the one that's previously --

DR. JAIN: More is more accurate to like timing-wise. That's correct.

The second one is fine fibers remain suspended for a long time but eventually get transported to the sump.

One of the highlights or insights of the test was that more debris was transported in shallower pools compared to the deeper ones, primarily because the flow velocities are slower in deeper pools.

DR. BANERJEE: I'm sorry, I don't get this point. This thing is surrounded by some sort of a filter which takes this mess out? Are you talking now about what happens inside the sump or --

DR. JAIN: No, from the containment floor, how this debris is transported along the floor. So if it is a deeper pool --

DR. BANERJEE: Oh, I see, a deeper pool?

DR. JAIN: Right.

DR. BANERJEE: I guess what's confusing is for a shallower sump --

DR. JAIN: A shallower pool.

DR. BANERJEE: Just the pool which is outside the sump, you're talking about?

DR. JAIN: That's correct.

DR. BANERJEE: Okay.

CHAIRMAN WALLIS: Is this because there is greater velocity in the shallower pool?

DR. JAIN: By just observation, like how does debris transport take place. It's not really tied down to the sump or head loss at this point.

MR. ROSEN: I envisioned this pool as being in a real loss-of-coolant accident as a violently-stirred situation. It's not going to be quiescent, allowing for fine material to deposit.

DR. LETELLIER: I will be showing some calculations of velocity fields where that is not true in general. These are very large containment volumes, very close to the break, what you say is an adequate description, but there are quiet areas where there's an opportunity for settling.

MR. ROSEN: Okay.

DR. LETELLIER: I think the important key feature that B.P. has already mentioned is that the fine debris is suspended indefinitely and will eventually transport.

DR. JAIN: And then there's narrow pathways that accelerate flow and enhance debris transport, and the debris curb impedes forward motion of the debris, which is a good thing if we want to control the amount of debris getting to the pool.

CHAIRMAN WALLIS: "Narrow flowpaths accelerate flow"? What you mean is narrow flowpaths lead to higher flow velocities?

DR. JAIN: That's correct.

DR. LETELLIER: Keep in mind that the recirculation requirements for most plants is largely the same, but their containment volumes and their geometries are very different. So that's what's driving the change in velocity.

MR. ROSEN: So in this case a large containment with a deeper pool is better than a small containment with a shallow pool, for this phenomena?

DR. LETELLIER: Yes.

DR. JAIN: That's right.

DR. BANERJEE: But the depth of the pool is sort of determined by what, barriers and things in the way of the water getting to the sump or --

DR. LETELLIER: By two features. Both their geometry, which defines the free volume, and also by their inventory of coolant water, both in the reactor coolant system and in the reactor water refueling storage tanks. Each plant has a finite volume of water that has to be managed to provide for long-term cooling.

DR. BANERJEE: So it's not like you have

internal weirs and resistances which keep the levels up?

DR. LETELLIER: Those effects are present, but that's not dominating the bulk pool velocity.

CHAIRMAN WALLIS: As long as it's going over surfaces, I would think it would be washed by the water and sprays and everything, washed down. So until it gets to a pool or a place where it can become stagnant, it's going to be in the water, and it's going to be washed down by the water.

So is there really just one pool you worry about? This is one big pool? I don't have a good picture of what happens in this containment. Different rooms and --

DR. JAIN: What I have described, he will have more description later on.

CHAIRMAN WALLIS: He will? Okay. An animated movie or something?

(Laughter.)

DR. KRESS: Cartoons.

CHAIRMAN WALLIS: Cartoons?

DR. JAIN: We could arrange that.

Here are some insights about debris accumulation and head loss. Fine debris accumulates uniformly. Debris on the vertical screen accumulates near the bottom of the screen initially and then, depending on the approach velocity, it piles up on the screen.

PWR head loss test data is consistent with the head loss correlation in NUREG-6224.

CHAIRMAN WALLIS: Isn't it sort of self-controlling? I mean, if it accumulates in one place, then it blocks that place, and so the flow goes somewhere else and, therefore, it accumulates somewhere else. So the screens tend to fill up.

DR. JAIN: Eventually, yes.

CHAIRMAN WALLIS: All right.

DR. JAIN: The PWR head loss data we have is consistent with NUREG-6224 correlations, and that correlation can be used with some adjustment to material property parameters to soothe the PWR materials.

CHAIRMAN WALLIS: Presumably, you have the screen there because you don't want this material to be put through the reactor?

MR. LEHNING: Through the reactor and any flow restrictions that may be downstream, like a throttle valve or a containment spray nozzle or pump seals.

MR. ROSEN: Maybe not through the pump --

MR. LEHNING: Yes, pump seals.

CHAIRMAN WALLIS: Yes. Well, the pump would probably be perfectly happy with some of this fine material.

MR. LEHNING: The seals of the pump. So the coolant --

DR. BANERJEE: Seams could be problems.

MR. ROSEN: Seals would not be --

MR. LEHNING: Yes, large quantities of debris could cause the pump to lose primes.

DR. BANERJEE: Are these labret seals? What type of seals on these pumps?

MR. LEHNING: They have different models, and I can't speak to every type of pump.

CHAIRMAN WALLIS: Yes, but the fraction, the volume fraction of debris in the water is very, very small, as long as it's all mixed up. Compared with the amount of water there, the volume of debris is very small. It's just that it's in the wrong place.

DR. JAIN: And the wrong size.

CHAIRMAN WALLIS: Yes, correct. It gives you trouble.

MR. LEHNING: Yes, I mean the problem could be like big pieces. If you didn't have that screen there, you may get a big chunk right there and you have a locally high concentration enough to cause a problem.

DR. JAIN: And then we also found that fibrous bed, in combination with the particulate debris, results in higher head losses. Bruce is going to have some slides on that, more details.

Next one. Acceptable analytical approaches: The Draft Guide provides analytical approaches that are acceptable to the staff. Bruce will provide more presentation of these approaches.

I want to re-emphasize that these are not the only approach the licensee can use. They can submit alternate approaches for our review.

We are also making available a NUREG that provides a summary of the current knowledge base of the research on BWR strainers and the PWR sump screen clogging issue. So whatever the knowledge base is there, it's available to the general public, and it will be issued concurrently with the Reg. Guide.

CHAIRMAN WALLIS: I guess when Los Alamos presented to us, whenever it was, a year ago or something, they had some analytical approaches. My feeling was, yes, this is fine, but then there is a lot of creativity in the way one analyzes the problem.

It seemed quite likely that a licensee or NEI would come back with an approach which predicts almost an order of magnitude different from LANL. Then someone has to resolve this.

DR. LETELLIER: As long as they're higher, then there's no conflict.

(Laughter.)

And I say that only partly in jest. Part of the reason for LANL developing these methodologies is to look at an appropriate level of effort and to help judge what is a conservative assumption and what's not.

DR. JAIN: And I think we should also keep in mind that the industry is fully aware of what was done on BWR and other places. So it's not something that they are reinventing the wheel. So we don't expect surprises to that extent.

DR. BANERJEE: Are these approaches, then, quite similar to the BWR methodology?

DR. JAIN: Well, they are, but they have been modified --

DR. BANERJEE: Sure.

DR. JAIN: -- where appropriate for PWRs.

DR. BANERJEE: But the basic thinking going into them is similar?

DR. JAIN: Correct.

DR. BANERJEE: And industry is using these approaches?

DR. JAIN: I would leave that for NEI later after Bruce. But, to answer your question, I assume so. But, again, we are open to look at alternate approaches.

Next one, please. Here I will list some of these contributions of the GSI-191 research program. It has provided -- it has been a program going on for the last four years, and has generated a lot of material and tools which industry can use.

Well, first of all, we confirmed the credibility of the Generic Issue, and also supported the agency's performance goal of maintaining safety by gaining knowledge regarding the effect of debris accumulation on PWR sump performance.

We have periodic meetings with the public, industry, ACRS --

CHAIRMAN WALLIS: Knowledge by itself doesn't maintain any safety. It's doing something with the knowledge.

DR. JAIN: Well, we are in the process of resolving that by Generic Letter. Eventually, we'll get there. That's a goal.

Then part of this research program, we have developed tools, some computer programs; for example, CASINOVA and BLOCKAGE.

CHAIRMAN WALLIS: This is about the least romantic subject. I don't know what "Casanova" has to do with it.

(Laughter.)

DR. BANERJEE: It's spelled differently, like "casino."

DR. JAIN: Yes, it's not spelled -- CASINOVA generates -- it talks about debris generation, volume, and composition of debris for all possible break sizes. Bruce will go into a little bit more detail.

BLOCKAGE code estimates the head loss.

As part of this program, we have developed numerous NUREG/CRs and, of course, this Reg. Guide 1.82 that has provided valuable insight to the industry for resolving this issue.

We have also developed the knowledge base, as I said earlier. The report summarizes U.S. and international research on the BWR and PWR clogging issue.

CHAIRMAN WALLIS: Well, let's go back to the Reg. Guide here. Aren't we going to talk about it, I suppose?

My impression of the Reg. Guide is it lays out what needs to be done. You have to evaluate this, you must consider this, and so on and so on. It doesn't really provide any insights because it doesn't tell you how to do it.

DR. JAIN: No. This is just a research program and we're talking about overall --

CHAIRMAN WALLIS: Yes, but the Reg. Guide itself is different. It's really asking for a lot of things, and my question all along was, do we know how to do it?

DR. JAIN: In the Reg. Guide we do provide reference to the NUREGs and acceptable methods.

CHAIRMAN WALLIS: There is reference, right?

DR. JAIN: Yes.

And the last bullet on this page, we plan to interact and share knowledge on the sump clogging issue with the international community, and we have planned an international conference later this year.

CHAIRMAN WALLIS: What is the status of things internationally? Are there other countries that are concerned with this problem? Are there other countries that have solved it in a different way?

DR. JAIN: Well, France is more active in this area, but they are sort of reluctant to share too much knowledge. So, to answer your question, we don't know much what they do. They have told us they will share their knowledge sometime later this year.

CHAIRMAN WALLIS: Don't they publish their regulations?

DR. JAIN: I haven't had a chance to look at their regulations.

MR. ARCHITZEL: The Belgian plants are looking at this issue right now, following what we're doing and interacting with their utilities, the regulator is. So they're struggling with it as well. I think the Swedish plants solved it because they had the problem at the BWR up there, so they solved it for the PWRs with large screen changes.

DR. FORD: Would you mind going back to the previous graph? Could you just go back one, to 45?

CHAIRMAN WALLIS: Maybe we should note for the record that our esteemed colleague, Dr. Peter Ford, has now joined us.

DR. FORD: Needless to say, I know very little about this subject. Could you tell me something about the last bullet? You developed tools, these computer programs, the qualification of them against observation?

I notice on slides 42 and 43 you have a whole lot of empirical statements like "more debris transported to the sump" and such things as these. Are these models empirical models in this CASINOVA? They're purely empirical, based on the information you have at any one time?

DR. LETELLIER: The BLOCKAGE model, which is intended to calculate head loss across the debris bed, is a semi-empirical model, which actually the correlations are based on chemical engineering fields that are intended for porous media filtration and also fibrous media. The empirical data have been used to finetune the parameters of that correlation. So it's a combination.

DR. FORD: So for the pump pressure, for instance, there's a correlation, there's an algorithm that gives the value of that as a function of a whole lot of empirical variables, like volume of fibrous things of this nature?

DR. LETELLIER: That's correct.

DR. FORD: And there's a correlation between observation and theory?

DR. LETELLIER: Yes.

DR. FORD: And it's a good correlation factor?

DR. LETELLIER: We'll be looking at some of those results, but in general the scatter between head loss measurements is like plus or minus 20 percent compared to the correlation predictions over a wide range of water temperature, volume of fiber, and mass of particulate in different compositions, different mixed debris beds.

DR. FORD: And someone has taken that plus or minus 20 percent and correlated it into risk?

DR. LETELLIER: We have implemented the BLOCKAGE code in both the parametric study, which formed the basis of the Generic Issue, a declaration of GSI-191, and we have also used it to look at pump vulnerability or pump performance at the end state of a risk analysis.

DR. FORD: Oh, okay. Thank you.

DR. LETELLIER: The CASINOVA model, I'll talk more about later. It is less based on empirical measurement because I think, as you'll see, it's very much a stochastic parameter study of break location and potential debris volume. While the zones of influence are based on empirical data, the results of CASINOVA have no baseline for comparison.

DR. FORD: Has anyone gone through -- you mentioned that it is an empirical code, based on the information you have when you developed it. Has anyone gone through the question as to what happens if there is another item that we've missed? I'm thinking of the question of epistemic uncertainties in this model you've got.

DR. LETELLIER: The issue of completeness is always a difficult one to address, but we're always looking for additional concerns, some of which have been raised by the ACRS. For example, the chemical effects of precipitation and effects of compaction on a debris bed.

CHAIRMAN WALLIS: I was going to ask you that. Does it compact?

DR. LETELLIER: Those concerns are being addressed in a forthcoming chemical effects study, and those observations will be folded into the correlations used by BLOCKAGE.

CHAIRMAN WALLIS: Compact depends on what it is. If it's fibers, then it's fairly resistant to compaction. But if it's sheets of paint or something like leaves -- and you don't get leaves in there, but if you had leaves, they would layer, and once you begin to squash them, they just act like check valves and shut the thing down completely. It doesn't take much to do that.

DR. LETELLIER: That's very true, and we always try to test or examine a variety of mixed debris beds for that reason.

DR. BANERJEE: Has there been much evidence of what type of debris beds sort of develop in PWRs or is it mainly BWRs that you've seen these in?

DR. LETELLIER: We have looked at the differences because, obviously, the transport mechanisms are much different in a suppression pool than they are in the containment pool. We've looked at this primarily from the point of view of transportability of the debris and whether there is a sufficient bulk pool velocity to move paint chips, for example, versus individual fibers.

So the bed morphology, the way that it looks is, can be, substantially different between the two, and we've try to address those differences. We've addressed it from the point of view of prioritizing our research investment to look at the predominant insulation types and the most transportable debris types when we carry this work forward to head loss testing.

So I would say upfront that we've never intended, and never achieved, a comprehensive test of all insulation types and all debris types. We've had the luxury in the past of being given the task of establishing a minimum level of concern. In order to do that, it wasn't necessary to be comprehensive. We could focus on the predominant mechanisms.

The much harder problem now perhaps on the side of the industry is to solve plant-specific problems where they do have debris types and flow conditions that have not been tested.

DR. BANERJEE: Now as part of this Reg. Guide you're suggesting references to various NUREGs, and so on, which could be used as acceptable methods of analysis, right?

DR. JAIN: Right.

DR. BANERJEE: Now are these acceptable methods of analysis going to be reviewed or have they been peer-reviewed? That seems one of the sort of crucial issues here.

DR. JAIN: Well, these are the NUREG developed by Los Alamos, and they have gone through their standard review process.

DR. BANERJEE: Right, but how do we know that -- Los Alamos may have reviewed it, but have they been peer-reviewed or is it not standard for these methods to be peer-reviewed?

DR. JAIN: To answer your question, no, they have not been peer-reviewed.

DR. BANERJEE: So other than Los Alamos, is there anybody else who says it's acceptable?

DR. LETELLIER: Each NUREG does go through the process of public comment, and that is an opportunity at least for other agencies, and particularly the industry, to make comments that we do address and incorporate.

DR. BANERJEE: Right, but it's not the same as having an article peer-reviewed for a journal or something?

DR. LETELLIER: That's correct.

DR. BANERJEE: Where you get scrutiny of a different nature.

DR. JAIN: That's right.

DR. BANERJEE: So the Reg. Guide stands independent of these matters, right, or do they depend on the methods?

DR. JAIN: Well, the Reg. Guide is --

DR. BANERJEE: It doesn't really matter? You can use anything that --

DR. JAIN: Right. As long as you tell us

what you have done, we review your methods. But it's not a requirement, what we say, "that thou shall use this" --

DR. BANERJEE: But, nonetheless, you offer a path. You could ask for the impossible otherwise, right?

DR. JAIN: That's right. We tell them one acceptable method, what is acceptable to us.

DR. BANERJEE: But now that method is not reviewed independently?

DR. JAIN: That is correct.

DR. BANERJEE: Is that true of all Reg. Guides or just this Reg. Guide?

DR. KRESS: It's generally true.

DR. JAIN: It's probably true for all Reg. Guides, but I'll let Dan or --

MR. DORMAN: I think probably the bulk of the Reg. Guides are endorsing consensus standards. So, in that sense, that process has been through a consensus development process. I think in this case the information developed in the research program has not reached the consensus standard point.

I guess one other thing I would point out in this context is that that I think Ralph pointed out the number of interactions with industry since the technical assessment was completed in September 2001. That was not when we started interaction with the industry.

There was substantial interaction and opportunities throughout the research program, outside of our research project, for people to come in and see what we were doing and comment on the way the work was being done and the findings and the development of these methods. So while there's not been a formal peer-review, it has not happened in a vacuum either.

CHAIRMAN WALLIS: Well, Sanjoy, we're also reviewing thermal-hydraulic codes. There's a Reg. Guide on thermal-hydraulic codes. It says things like, you know, you must state your fundamental equations; you must state the assumptions you're using; you must sort of explain how it relates to experiment, and all that.

This is all at that sort of general level. These are criteria for evaluation, but it doesn't really go into the detail of which forms of these equations are acceptable. Then that's, I think, the weakness because then something comes to the ACRS and we look through this thing and say, "Gee whiz, you know, we don't like this equation."

DR. BANERJEE: Or it's wrong, more likely.

CHAIRMAN WALLIS: Yes.

DR. BANERJEE: And then what do you do?

CHAIRMAN WALLIS: We say it. But then we say, why does it have to come to us? Why wasn't it found before? So I guess this is an interesting point here. What's an acceptable method? It may depend on who the peer reviewers are.

DR. BANERJEE: But it's subject to at least staff review, right? NRC staff review it and sign off on it. They have the ability to ask for a peer review at that point, if they wish. Do they?

MR. DORMAN: Yes, and also in the context of the staff review, it's reviewed by the research staff which sponsored the work. We also provide the Draft NUREGs to the program office for independent review and comment at a draft stage in the NUREG process. So before the NUREG is published by the Office of Research, it does get review from, in this case, NRR, but that is not something that we categorize as a formal peer review.

CHAIRMAN WALLIS: It really does help public confidence if you can get some outsider to do reviews.

DR. JAIN: May we go to current plans and schedules? We are planning to issue this Draft Reg.

Guide for public comment in February, later this month, and issue this Reg. Guide as 1.82, Rev. 3, in September. The NEI will issue their guidance in the fall of 2003.

In conclusion, we are at the regulation and guidance stage. The Draft Reg. Guide is scheduled for public comment, and implementation, regulation, and verification will follow, as Ralph has gone over, Ralph and John. Eventually, this will lead to effective closure of GSI-191.

CHAIRMAN WALLIS: So what do you need from the ACRS?

DR. JAIN: We need your concurrence that we can issue this for public comment.

CHAIRMAN WALLIS: Do you want a letter or to --

DR. JAIN: I think formally that's what --

CHAIRMAN WALLIS: A letter that says that? You would like to see a letter to EDO, or whoever is appropriate?

DR. JAIN: Well, we sent a letter to the ACRS office requesting that be done. So I guess you need to respond to that letter.

MR. ROSEN: I would ask if a Larkinsgram would be good enough.

CHAIRMAN WALLIS: Yes, a very short letter which simply says we have no objection to this being issued --

DR. JAIN: That's right.

CHAIRMAN WALLIS: -- would be okay with you?

DR. JAIN: That will be fine.

MR. DORMAN: Yes, that would be fine.

CHAIRMAN WALLIS: Unless you have something you find is a sticking point?

MR. DORMAN: Yes, frequently, with Draft Guides, we send them down and request that you defer your review until the final Reg. Guide stage, and the response at that point is a note from John indicating that you have no objection to issuing the Guide for comment, and I think that would be suitable in this case as well.

CHAIRMAN WALLIS: Personally, I think that this may be appropriate, but I do worry about the quality control of the analyses which then gets submitted by the industry.

MR. ROSEN: I don't think we know anything about the way the analyses will be done, and we reserve judgment.

CHAIRMAN WALLIS: Well, we may never see

it.

MR. ROSEN: That would be a problem to me, and that's the crux of the issue.

MR. ARCHITZEL: For this issue here, I think it's incumbent on us to show you the guidance that's used. We weren't initially planning to come necessarily with the Generic Letter, but we were planning to come once the guidance was in place. We still have to come back with you with the guidance menus to resolve this issue, which is industry, or however we agree or disagree --

CHAIRMAN WALLIS: You have to come back to us with that?

MR. ARCHITZEL: As part of the resolution of the Generic Safety Issue --

CHAIRMAN WALLIS: You have to?

MR. ARCHITZEL: -- it's required.

CHAIRMAN WALLIS: Okay.

MR. ARCHITZEL: But not necessarily for issuing like the Generic Letter.

CHAIRMAN WALLIS: Okay.

MR. DORMAN: Ultimately, I think the management directive process for GSIs will bring us back to you.

CHAIRMAN WALLIS: These GSIs take a long

time, don't they?

(Laughter.)

DR. RANSOM: One thing I didn't quite understand is the relationship between the Generic Letter and the Draft Regulatory Guide. I see your references, Reg. Guide 182. Is the intention that the Generic Letter would direct people to use the methods that are outlined in this revision?

MR. LEHNING: No. The Generic Letter states that in this guidance we assume that it will be acceptable to use and we will come back, if it's not acceptable, and supplement somehow and tell licensees of exceptions or additions we have.

The Reg. Guide, we referenced the Reg. Guide in there as an acceptable way of complying with the requested evaluation, but we're not telling licensees that they have to use that Reg. Guide.

DR. RANSOM: Well, why -- I'm not sure I understand then why you later come out with this Reg. Guide Revision or DG-1107, which seems to have specifics in terms of what they should do.

MR. LEHNING: Well, the Reg. Guide, I mean the reason why it's coming out now, I mean it's for future plants. It does have more specifics than the Generic Letter, but the industry guidance that we anticipate will come out would be even more specific than that.

So the detailed guidance will come, and licensees can choose what they want to do. We're not telling them to choose one method or the other with the Generic Letter.

DR. JAIN: For example, you can see the guidance for BWR is this thick reg. here. So we expect that kind of detail for PWRs.

CHAIRMAN WALLIS: So there are two things we have to do. We have to recommend that you issue the Generic Letter, or is that not our business?

MR. ARCHITZEL: I think procedurally it wasn't an option. We didn't -- I think it's up to --

CHAIRMAN WALLIS: You're going to do it anyway. We don't need to be involved.

MR. ARCHITZEL: No, but once you've had the meeting, I think we need sort of an endorsement --

CHAIRMAN WALLIS: So you need it is okay to send out a Generic Letter?

MR. ARCHITZEL: The General Letter process has you involved at your option, and you've chosen to be involved. So we would expect that you would say okay.

CHAIRMAN WALLIS: Okay, that actually asks industry to do something, and then the Reg. Guide goes out for public comment. Nothing happens until the public comment comes back and it's all resolved, and so on.

DR. JAIN: That's right, and you give them a chance to look at it.

MR. DORMAN: Both documents at this stage are draft going for public comment.

MR. ARCHITZEL: Yes, that is correct.

CHAIRMAN WALLIS: The public actually comments on the Generic Letter, too?

MR. DORMAN: That's correct.

MR. ARCHITZEL: But if there weren't substantive comments in the public comment process, we may waive a second meeting with you at that stage. It depends what the comments are like whether or not we want to have another meeting on this.

CHAIRMAN WALLIS: I would think a Generic Letter would go out without public comment at all.

MR. ARCHITZEL: That's bulletins. No, no Generic Letter can go without public comments because our procedures have been changed.

CHAIRMAN WALLIS: It seems to me, then, that the industry can slow it down forever by always commenting on it.

MR. LEHNING: Well, we've got a time period on the comments.

MR. DORMAN: There's, I think, a 60-day comment period.

MR. LEHNING: We don't promise to consider anything after the comment period closes.

CHAIRMAN WALLIS: And we might include in this letter some sort of a comment that says all this depends upon the analytical methods proving to be valid?

MR. LEHNING: In the Generic Letter, you're asking?

CHAIRMAN WALLIS: No, when we write our letters to you.

MR. LEHNING: Oh, oh.

CHAIRMAN WALLIS: We might say, yes, this is fine; send it off for public comment, but the resolution, the final resolution, depends upon whatever methods come up from this process of being suitably valid and appropriate.

MR. ROSEN: I think the key to this, Graham, is the NEI document on how to do evaluation, not this one how to --

CHAIRMAN WALLIS: Which we haven't seen at all.

MR. ROSEN: That's right, we haven't seen that one at all. When the staff chooses to endorse that NEI guidance or not to endorse it, that's the point in time when we --

CHAIRMAN WALLIS: So we don't need to say anything because we're going to get a chance to do that anyway? Is that right?

MR. ROSEN: Yes, that's the point in time when we should weigh in.

CHAIRMAN WALLIS: Okay. So it's just a brief thing now. We'll really get to the meat in half a year, or whatever?

MR. ROSEN: This is the situation I find myself in now for the second time. Last time when we saw the results, I said, gee, this is important; I think we ought to get on with it. The word the ACRS chose was "expeditiously."

Then there was a long period of time and we're back. Now we get to have that same feeling again: Gee, this is an important problem; get on with it expeditiously.

CHAIRMAN WALLIS: Just like the boron slug problem where everything is going to happen and then it turns out the analysis isn't quite convincing, so we have to go around again?

MR. ROSEN: I would suspect that we're getting to the harder part of it. The hardest part of it will be how to analyze this.

CHAIRMAN WALLIS: That's right.

MR. ROSEN: Not how to find out how much debris you have, although that's a necessary and useful step, and the NEI guidance addresses that.

CHAIRMAN WALLIS: Well, I like the statement in the Reg. Guide which says that, if you can't figure out where the debris, you had better assume it all goes onto the screen.

(Laughter.)

DR. JAIN: Well, that's one of the options.

DR. BANERJEE: And, presumably, if the methods are followed that you refer to in your Reg. Guide, then they're home free. NEI doesn't have to do anything. They can say, "We like CASINOVA," or we like whatever, and you just do it this way.

DR. JAIN: That's right.

DR. BANERJEE: It's a done deal, right?

DR. JAIN: It's a done deal.

DR. LETELLIER: I would caveat that by saying that, again, there may be plant-specific conditions that have not been analyzed that are not represented in the database. So it's not a simple matter of just adopting a tool off the shelf. The methodology is sound from our point of view, but there may be additional work required.

DR. BANERJEE: Then you would come back to us, hopefully, and say: Look at CASINOVA and look at whatever else.

DR. JAIN: Yes, these are the approaches. These are not really a method like one, two, three, four, and as we progress you meet the spirit of that approach. That's what we're looking for.

With that, I'll ask Bruce to go over his presentation.

CHAIRMAN WALLIS: Thank you very much. I think it's about time we had a break. We've been going for two hours, and we have, hopefully, somewhat less than two hours to go. If it's okay with you -- you'll probably be glad to take a break.

DR. JAIN: That's fine. We can come back after break.

CHAIRMAN WALLIS: Okay. So we'll take a break until quarter past 3:00.

(Whereupon, the foregoing matter went off the record at 3:02 p.m. and went back on the record at 3:18 p.m.)

CHAIRMAN WALLIS: We'll come back into session. So we are ready.

DR. LETELLIER: Good afternoon. I apologize for not introducing myself sooner. I'm Bruce Letellier. I'm here to represent the work that Los Alamos National Lab has been doing in support of the NRC over the past three years.

Initially, we were working for the NRR to conduct the BWR closeout, resolution of their sump blockage concerns. In the interim we've helped the Office of Research conduct the program that we're going to talk about today, researching debris characterization, transport properties, and head loss. Most recently, we are now supporting the NRR, looking at the revised Reg. Guide and regulatory implementation of findings.

In the position of speaking last, I find I have the pleasure or the blame of responsibility for answering all the questions that have been deferred.

(Laughter.)

So please remind me of the issues that we've had to skip over. I will be touching on all aspects of the accident scenario. So I think you'll find a place to ask your questions at the right time.

I also hope that, as we look over these

slides, you'll get an impression for the technical basis that supports the draft guidance as it is and which forms the basis for the methods that we are proposing or making available to industry.

On slide No. 2, a brief overview of the talk includes the three major components of the accident scenario: debris generation, debris transport, and, finally, accumulation. Finally, in summary, I'll talk about how these are integrated into an overall vulnerability assessment.

DR. KRESS: Implicit in that debris generation is the size distribution?

DR. LETELLIER: Yes.

DR. KRESS: Okay.

DR. LETELLIER: As a brief introduction, and perhaps we could have started the afternoon with this discussion -- excuse me one moment.

Slide No. 4, we should have reviewed the accident progression to give a visual context of what actually happens. In the lefthand frame there's a schematic of a containment structure with a damage zone or zone of influence, highlighted as a circle, shaded circle.

If a pipe were to rupture, by whatever mechanism, there would be two components to debris generation: first, a shockwave, which might loosen bands and jackets, soften pliable materials like Calcium-Silicate. Quickly following the shock effects would be the erosion jets, which actually generates the bulk of the insulation debris, not just insulation but also coatings and concrete erosion.

MR. ROSEN: Does the shock effect apply to insulation quite remote from the zone of influence?

DR. LETELLIER: I would have to answer no. The tests for debris generation that have been done are intended to measure the distance or the extent of this damage zone. So the damage mechanisms have been investigated out to an appropriate threshold for each insulation type, and they do not extend beyond -- well, they can extend to distances as far as 30 pipe diameters. So that is a significant fraction of containment in some cases, but the damage mechanisms have not been investigated for shock reflections across the entire containment.

MR. ROSEN: What I was trying to do was to narrow what we have to worry about. What I think your answer says is that you can't do that because the effects of the jet will be local, relatively, but the effects of the shockwave could be remote from the zone where the jet occurs. In other words, you could have compaction of silicacious insulation on the other side of the containment and up above the steam generators, for instance, just in the diagram. Am I reading you right?

DR. LETELLIER: Yes, that may be true, but let me define the zone of influence. This outer contour that's represented by the shaded circle, that is the maximum extent to which insulation blankets can be removed in large pieces or partially complete portions of the blanket. Internal to that zone are the smaller fragments, and closest are the particulates and the fines.

MR. ROSEN: I want to zero in on what you just said. That's the zone where large pieces could be removed?

DR. LETELLIER: Inside this damage radius.

MR. ROSEN: Now outside there small pieces could be removed?

DR. LETELLIER: No. No, the jet pressures are highest on the interior. So the damage mechanisms tend to shred material from the finest on the interior to the large fragments on the exterior zone.

CHAIRMAN WALLIS: It's funny that it's a circle.

MR. ROSEN: You're answering me that I

only need to worry what's inside this orange circle that you've drawn?

DR. LETELLIER: That's correct. The point you raise about the shock effects have not been thoroughly investigated. Beyond this damage contour, there would not be immediate displacement of the insulation. If it were degraded by some means due to the shock, it would only be introduced as a debris through erosion for containment sprays, but there would not be any evidence of damage to the jacketing material.

MR. ROSEN: Well, you're talking exactly what would happen. I mean these things would be damaged to some extent you're saying? And the next thing that would happen sometime later is the containment sprays would come on and spray them.

DR. LETELLIER: Yes.

MR. ROSEN: So isn't it possible, then, you could get more debris from those mechanisms outside the orange circle?

DR. LETELLIER: We have looked at the potential for erosion of Calcium-Silicate, but the standard position at the moment is that, if the jacketing material is still in place, that the erosion is not significant. So we are confining our damage zone to the minimum pressure needed to show evidence of damaging the insulation.

CHAIRMAN WALLIS: Where is the break?

DR. LETELLIER: In the center of the orange circle.

CHAIRMAN WALLIS: In the center? I would think it would be directional; it would come out of a cold leg, let's say, and they would squirt in some direction.

DR. LETELLIER: Of course it would, and that's a difficulty, a limitation, if you will, of this representation, is that we don't have a predictive model for jet deflections near concrete. We don't have a predictive model for pipe separation. For example, the two ends of a guillotine break may be opposed, generating opposing cones.

The standard practice is to look at the free-field jet expansion and investigate the damage threshold of different insulation types. The interior volume of that pressure contour is mapped into an equivalent sphere for the purpose of plant assessment.

DR. RANSOM: Well, in fact, you're probably assuming a spherical source, I would guess, and a spherical shock that drops off with r-squared as you expand, and at some point you get down to the place where forces are small.

MR. ARCHITZEL: Well, I just did want to say one point: that this was based something on the BWR solution, and these issues were addressed, these complexities were resolved on that basis for the BWR. Some of this isn't new for PWRs, although maybe you do want to revisit the base. So I'm just saying that was the solution on the BWRs. It's too complex. So they took the sphere approach instead of double cones and things like that.

MR. ROSEN: I'm concerned, of course, with uncertainty. How likely is it to be your model doesn't envelope a significant fraction of the phenomenology?

DR. LETELLIER: We are investigating the geometry of the break region, both opposing cones from a double-ended guillotine break, a single-directed jet from a fishmouth opening in random direction, and trying to look for major differences in the range of potential debris volumes, for example.

MR. ROSEN: I'm encouraging you that it's fine to start with a simple model to begin with, but, ultimately, to deal with the uncertainties, one needs to look at more elaborate model considerations.

DR. KRESS: This zone of influence is a

sphere, and it defines ultimately the total volume of debris that might get late airborne.

DR. LETELLIER: That's correct.

DR. KRESS: And you just look in that sphere. Now my question is, is there an empirical relationship of some sort that determines that volume of debris, I mean that volume of the zone?

DR. LETELLIER: Yes.

DR. KRESS: And it has to do with pressure of the system and --

DR. LETELLIER: It has to do with the pressure, the stagnation pressure, needed to show significant evidence of damage. That is arrived at empirically by looking at free-field jets --

DR. KRESS: Free-field jets?

DR. LETELLIER: -- where insulation is placed at different distances on the jet center line until there is no -- until it's far enough away that there is no evidence of damage.

DR. KRESS: Now you aim that jet in different directions?

DR. LETELLIER: Once the pressure for damage has been established --

DR. KRESS: Okay, and that would be a function of the type of insulation or whatever debris sources --

DR. LETELLIER: Yes, sir, it is. Once that pressure has been established, then the volume of the free-field jet at that pressure contour is mapped into an equivalent sphere.

DR. KRESS: Now that's a cone?

DR. LETELLIER: It would be.

DR. KRESS: Now how do you decide on what the spread angle of the cone is? Is that input to this?

DR. LETELLIER: It actually depends on the size of the opening, the pipe size, and so --

DR. KRESS: You fix it as a function of pipe size?

DR. LETELLIER: That's correct.

DR. KRESS: Okay.

DR. LETELLIER: So these zones are both a function of pipe size and also of debris type.

DR. KRESS: Okay.

DR. RANSOM: Have these been done with water that will flash into steam?

DR. LETELLIER: Most of the data is based on surrogate jets for the BWR study, which used both air and steam surrogates, and we are acknowledging the differences in the PWR blowdown condition. You will see where we have attempted to scale the debris generation data to account for those effects.

MR. ROSEN: We're talking about pressures twice the BWR pressure?

DR. LETELLIER: That's true.

MR. ROSEN: So is that important in making --

DR. KRESS: That fixes the distance to --

DR. LETELLIER: It is. If we could defer that question to a later slide, we'll see and we can talk about it in more detail.

MR. ROSEN: Okay.

DR. LETELLIER: Once the debris has been generated in this orange circular representation, the thermal expansion will carry this material to every corner of the containment. We have used the MELCOR model, which is intended for severe reactor accident modeling, to demonstrate that the entrainment velocities are sufficient, both vertically and laterally, to carry large pieces of debris.

DR. KRESS: That depends on the size and density and the shape of these things.

DR. LETELLIER: It does.

DR. KRESS: Is that an input to this system or how is that determined?

DR. LETELLIER: We do not have a predictive model of the blowdown transport. I think you'll see later we're attempting to use an engineering logic diagram to itemize, if you will, what the potential transport pads for this material would be.

The same is true of the washdown. Obviously, at a sufficiently high pressure, containment spray will begin to bring this material back down to the floor.

It's important to remember that this damage radius is the maximum extent observed to cause damage into large pieces. At distances closer than that, you will have a range of different size distributions, and that is also provided by data, empirical observation.

So we do have some estimate of the size fractions --

DR. KRESS: That determines what remains airborne long time --

DR. LETELLIER: Yes.

DR. KRESS: -- versus what doesn't?

DR. LETELLIER: That's correct.

Containment spray can be very effective at washing material back to the floor. We're using, again, logic diagrams to look at the fraction of vertical surfaces impinged by sprays. We're looking at steam condensation and rivulet formation.

CHAIRMAN WALLIS: The spray is that blue thing along the top there, is it?

DR. LETELLIER: Yes, intended to represent --

CHAIRMAN WALLIS: Which covers the whole containment. What are these fireworks or pinballs or something? I don't understand the yellow thing.

DR. LETELLIER: Debris pieces.

CHAIRMAN WALLIS: Those are bits of debris?

DR. LETELLIER: Yes.

DR. KRESS: That's a cartoon.

DR. BANERJEE: He said it goes everywhere, so it's everywhere.

DR. LETELLIER: There is a potential for this debris to be carried into the upper regions of containment. In a steam-rich environment, some fraction of this material will be stuck on surfaces and retained.

DR. BANERJEE: But a bounding calculation would be to say everything within that sphere, based on some size distribution, goes to the floor, right?

I mean the rest of it is sort of pencil sharpening?

DR. LETELLIER: That's correct. Furthermore, to be more conservative, you could say that 100 percent of that material arrives on the screen, on the sump screen. So we're trying to use some engineering judgment to try to find an appropriate level of conservatism. Our initial estimates show that it's very hard to rationalize a reduction factor of more than 50 percent due to retention on surfaces and the impingement of sprays.

So there's not a great opportunity for savings there. We're talking a factor of two perhaps.

CHAIRMAN WALLIS: So this is the insulation material which is blasted out over the containment, but, presumably, the concrete dust and the flaking paint and all that gets washed down by the sprays?

DR. LETELLIER: Well, that material will also be dislodged and carried during blowdown to other regions of containment. Eventually, it's all subjected to sprays.

CHAIRMAN WALLIS: Well, if you just turn on the sprays with no LOCA at all, you would still wash stuff down to the sump?

MR. ROSEN: Yes, and we've done that

several times, purposely.

CHAIRMAN WALLIS: But you actually have data for that because these guys have done it.

DR. KRESS: Yes, but they didn't measure anything --

CHAIRMAN WALLIS: But you had to clean up.

DR. KRESS: -- with an instrument.

CHAIRMAN WALLIS: You had to clean up the mess.

MR. ROSEN: Of course.

DR. LETELLIER: The issue of resident debris, both particulates and fibers from human hair, radiation containment clothing --

CHAIRMAN WALLIS: There can't be much human hair in containment.

(Laughter.)

DR. LETELLIER: I think the NEI may have some comments. That's a current area of investigation, where they're trying to characterize plant cleanliness.

But you're exactly right, there will be material washed to the sump, regardless of what is formed in the jet.

MR. LEITCH: What have we assumed about the type of insulation here? Are we assuming it's all metal-jacketed, some type of insulation?

DR. LETELLIER: You'll see a table later on which looks at the damage pressure for different applications of insulation and different types, both jacketed in fiberglass blankets and unjacketed.

DR. KRESS: Does that mean there's three or four of these spheres that are different size depending on the insulation?

DR. LETELLIER: That's correct, for each break location.

DR. KRESS: Each break location?

DR. LETELLIER: Yes. The center lower panel describes pool transport. The recirculation pool depth varies greatly between plants. It could be anywhere from one-and-a-half to six feet in depth, depending, again, on the geometry of the plant and their finite inventory of water.

In the figure --

CHAIRMAN WALLIS: The pool essentially covers the whole floor?

DR. LETELLIER: It does.

In the figure, the shaded circle in the center is intended to represent the splash zone from a break. The pipe could be elevated, but the break is extruding water onto the floor, and it's driving the debris away from it. That's what the arrows and the dots --

MR. ROSEN: Could you show us, using a pointer or get up and show us, the shaded circle in the center?

DR. LETELLIER: This is the splash zone, the break, and it's driving material away from it in every direction. These debris pieces will eventually migrate to a sump zone, the location of which is very plant-specific.

There are plants where the sumps are located in exposed locations, very close to the cold leg, hot leg of the steam generators. There are plants, as shown here, where the sump is in a remote location, and the migration path is significant, and there's a combination of geometries in between.

Again, there is an opportunity for debris to settle in regions of the sump -- in regions of the containment pool, and not be transported to the screen. That was the focus of the research effort over the past three years, is to characterize the transport phenomena of various sizes and types of debris fragments.

The material that does arrive on the screen is shown on the upper right panel, and the sump screen configuration comes in a variety of different types. This shows a fully submerged sump with vertical screens.

DR. KRESS: Could you explain to me once again -- you have a surface area for this pool, which is basically the diameter of the containment.

DR. LETELLIER: That's right.

DR. KRESS: Is it the assumption that all of the debris is uniformly distributed in the containment volume, so that when it falls out, it distributes itself uniformly over that whole surface or is there some other assumption made?

DR. LETELLIER: We're looking at the return pathways for water to cascade down the various floors from the containment. So it will be preferentially returned at stairwells and drainage holes that have been designed for that purpose.

DR. KRESS: Okay.

MR. ROSEN: Now the sump that you've shown doesn't have any vortex breakers in it, and some plants have installed those kinds of things.

DR. LETELLIER: The solid top could represent, in a schematic fashion, that could represent a vortex suppression, depending on the elevation above the sump outlet.

MR. ROSEN: I was just thinking or the question was, what effect do these -- have you looked at the effect of various vortex breaker designs on this problem?

DR. LETELLIER: The answer is, no, that we have not. We're actually more interested in the bulk flow velocity at some distance away from the sump screen. It's sort of assumed that, if you get close enough, the velocities will be high enough to attract the debris. We're more concerned about retention, or the opportunity for retention, in quiet areas of the containment.

Just briefly, in contrast, there are also containment screens that are not fully submerged that actually have the water level at some height on the screen. There are sumps that have horizontal screens at or below the floor level. So there's quite a variety throughout the industry.

Just a quick illustration to demonstrate that we've examined all aspects of this accident sequence, and, in fact, at the initiation of the research program a PIRT panel was convened to make recommendations about the phenomenology that were important to be investigated.

We've looked at thermal-hydraulics of the accident condition. We've looked at debris generation, both through experiment, historic and current, and also CAD simulations. We've looked at debris transport, using computational fluid dynamics and also extensive flume testing. We've looked at debris accumulation and head loss testing. Finally, we've looked at sump performance from a systems perspective, looking at the risk analysis.

This entire study has been generously supported by the industry, and we are relying on them for plant-specific data through our volunteer plant analysis, and also drawing on their experience from the BWR work that was done previously.

DR. BANERJEE: Now there are lots of presumptions you've had to make, right? Have you sort of systematically listed this in your documents and what these assumptions are and how you developed them?

DR. LETELLIER: On the next slide is a list of documentation that has been generated over the course of the three years. I think if you read this carefully, you would see at least one NUREG that has been published on each aspect of the accident sequence.

There are itemized limitations of the analysis in each report. I would not say that there is a single cover that packages all of the shortcomings.

DR. BANERJEE: So to get a view of this, one would have to read about something like 10 volumes of stuff?

DR. LETELLIER: The second-to-the-last bullet, the Knowledge Base Report, is intended to be a compilation of citations, of bibliography, if you will, with a brief discussion of the phenomenology at each stage. I think that has been found to be a very helpful resource document.

DR. BANERJEE: So what is the key assumption or assumptions here? What affects the results the most?

DR. LETELLIER: I think from a plant-specific perspective the flow conditions of their sump screen will be the most important consideration, and also the insulation types that they have chosen to implement. The combination of those two issues are the most important factors that seem to vary from plant to plant.

There are other aspects, such as the containment spray capacity and the recirculation volumes, that are more or less in common.

CHAIRMAN WALLIS: Those aren't

assumptions, though? I mean the volumes and insulation types are facts. I think he's asking you what kind of physical assumptions do you have to make to do the analysis.

DR. BANERJEE: And what is the analysis most sensitive to? If you go back to the previous slide -- no, no, not that one. The one with, yes, all those little things.

CHAIRMAN WALLIS: Of the T/H models, for instance.

DR. BANERJEE: Yes, you've got all sorts of things there. There must be a size distribution for the debris that could be, I don't know, the CFD analysis, the kapsilon model you've stuck in, the deposition models, head losses you've assumed. What's the most important?

DR. LETELLIER: Of course, there are assumptions at each stage in this analysis --

DR. BANERJEE: Right.

DR. LETELLIER: -- as you have pointed out. If you don't have confidence in your predicted capability, you always tend toward a conservative assumption; for example, 100 percent debris generation, the entire containment inventory, 100 percent transport. If you choose that path, you eventually come down to the question of head loss and what the debris type, what the composition of the debris --

DR. BANERJEE: So the size distribution?

DR. LETELLIER: Not necessarily the size distribution, but more the physical aspects of the insulation and how they relate to head loss. You'll see comparisons later between fiber beds and mixed beds of fiber and Cal-Sil, for example.

DR. BANERJEE: So the key is the head loss assumptions --

DR. LETELLIER: It is.

DR. BANERJEE: -- and the composition that deposits on the screens --

DR. LETELLIER: That's correct.

DR. BANERJEE: -- when all is said and done?

DR. LETELLIER: In fact, that was the basis for the parametric study. We actually looked at the vulnerability of each of these plants in a generic way using homogenized insulation types, for example, but we worked the problem backwards, asking ourselves, what's the minimum amount of debris transport necessary to induce a problem? That is the key aspect, ultimately.

DR. BANERJEE: So if you've got fiber and particles, you've got a thin layer of debris which would be enough to jam everything or not?

DR. LETELLIER: It depends a great deal on the flow velocity and the screen area of the sump.

MR. ROSEN: Now what I want to do is try to get a feel for how big a problem this is. If you'll go to your next slide with the references, the documentation, the third bullet, "The Impact of Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency," what is the answer? Is it, if you were to assume recirculation fails in a typical PWR PRA, what percentage of the core damage frequency are we talking about?

MR. ARCHITZEL: You might want to use that slide on the operator recovery actions they had.

DR. LETELLIER: I don't actually have the slide at the moment. I think your question is, what is the effect on core damage frequency?

MR. ARCHITZEL: It's on the other presentation, if you want it.

DR. LETELLIER: I think I can quote the results.

MR. ARCHITZEL: Fine.

MR. ROSEN: I mean, is this a 1 percent

effect, a 20 percent effect, 100 percent or --

DR. LETELLIER: No, if you look at traditional estimates of initiating event frequency for a LOCA using a traditional basis, and then you incorporate the effects of debris on sump performance, you get a factor of 170 increase in the average core damage frequency.

MR. ROSEN: One hundred and seventy?

DR. LETELLIER: That's correct. If you later go back and incorporate the opportunity for recovery action, you still get an increase of about 17 over the average core damage frequency.

MR. ROSEN: So this is a very significant problem. It could be two orders of magnitude?

DR. LETELLIER: That was, indeed, the motivation for recommending plant-specific analyses.

CHAIRMAN WALLIS: You may be doing it fairly rapidly.

DR. BANERJEE: What mitigatory actions are you talking about to drop the frequency by a factor of 10?

DR. LETELLIER: We're looking at opportunities for the plant operators to actually inject additional cooling water, to invoke backflush or active systems to realign pumps, to try to mitigate the effects of head loss.

Now there's a variety of different strategies and they're not all available at each plant. The effectiveness of recovery action is driven largely by human error factors and the uncertainty of the effectiveness of each of these strategies.

DR. BANERJEE: So the 170 or 117 -- I've forgotten -- comes from basically ECC not being effective?

DR. LETELLIER: Due to the presence of debris, that's correct.

DR. BANERJEE: The long-term cooling --

DR. LETELLIER: Yes. Traditional estimates of ECCS effectiveness did not consider the presence of debris in their performance characterization.

CHAIRMAN WALLIS: I think in the rules the ECCS is mainly supposed to work. If your ECCS doesn't work, it doesn't really matter what the core damage frequency is; you're not in compliance with the rules.

MR. ARCHITZEL: I would like to just make a comment because, when this number has come up before -- Gary is not here to defend his position, but --

DR. WEERAKKODY: Well, I can try to answer it. I'm Sunil Weerakkody. I'm from NRR.

If we assume that ECCS will not work with certainty, obviously, you're going to get a significant increase in core damage frequency.

MR. ROSEN: Well, wait a minute. We're not assuming ECCS will work. We're only assuming the long-term recirculation won't work, right? Injection will work?

DR. WEERAKKODY: Injection will work, but almost every, at least the way the PRAs are modeled, most PRAs assumes that every sequence that requires injection also will require this recirculation. So that's why, when you do a quick calculation using a PRA model and assume ECCS, the long-term recirculation fails, you're going to get a very high -- you said a factor of 170. It depends on the pond, but it could be a factor of 40.

But, then, when you bring the additional information to bear -- you know, let's say, for example, small LOCAs. We have had actual eight more LOCAs in the industry over the last 20-30 years, and we never had to go to recirc. So when you bring the realism, we know the problem is much less significant than that.

So I think we are dealing with the magnitude of or the nature of the uncertainty in the conclusion that this is a terrible concern, so the ECCS may not work. I don't know whether that helps, but the numbers come out very high. However, when you look at the small LOCAs, medium LOCAs, and then the plant estimates, there are a number of considerations in that estimate.

MR. ROSEN: Well, I think the small LOCAs and medium LOCAs are included in the 170.

DR. WEERAKKODY: Yes. Yes, sir.

MR. ROSEN: They're all at 170, even though many small breaks don't go to recirculation ever. Is that right?

DR. WEERAKKODY: That is true, but when you do the calculation, if you take the small LOCA sequences for a number of PRAs, you would find that they would require some recirculation. That's a conservative PRA model.

MR. ROSEN: Let's try to simplify this. Any break that requires, that is large enough to require, recirculation goes to core damage.

DR. WEERAKKODY: That's correct, yes.

MR. ROSEN: That's what I think you're saying, and that's why you get 170. Any breaks that are too small to require recirculation, well, they don't go to core damage because this doesn't affect that number. Your other sumps may be plugged up but may never turn on.

DR. LETELLIER: It is not true that we're assuming 100 percent sump failure. We are looking at the potential for degrade sump performance.

MR. ROSEN: Okay.

DR. LETELLIER: That's included in the estimate.

I would like to remind you that this PRA study was done with a very representative plant model. It is not specific to any single licensee, and we tried to do it broadly enough to incorporate the various mitigation mechanisms.

MR. ROSEN: That's a weakness. I mean it's both a strength and a weakness. It's a strength because it tells you something right away.

DR. LETELLIER: Right.

MR. ROSEN: The weaknesses, we know from long and painful experience that PRA answers are plant-specific.

DR. LETELLIER: That's correct.

Well, now that we've finished with the introduction (laughter), we'll proceed, and probably very quickly, with the other aspects of phenomenology.

Debris generation, as far as the break

location: You have already asked many of the relevant questions regarding the break location, but I wanted to remind you of what the verbiage is in the guidance specifically. On slide No. 8 you can read those.

I wanted to point out that it's not focused exclusively on the maximum volume of debris, but it also requests that you look at medium and large breaks with the largest particulate-to-fiber mass ratio. This is in deference to the potential thin bed effect that's been discussed previously.

On slide No. 9, I would like to show briefly what sort of methods that LANL has developed to approach these issues and what the bases are for our recommendations in the Reg. Guide.

Obviously, to assess the location of a break and what insulations will be impacted, a spatial plant model of some type is very helpful. You have to know what your piping diagrams are and what insulation applications have been chosen. If you intend to look at a distribution of break sizes -- well, in fact, to assess the breaks requested in the Reg. Guide, you need to have this sort of information present.

If this model is flexible enough, you can gain a great deal of additional information about the range of accident conditions. That's what we have embodied in the CASINOVA model.

CHAIRMAN WALLIS: It seems to me that this business of structure and equipment offering confinement and sheltering goes against your rather simple idea of the zone of influence, which is vertical?

DR. LETELLIER: It does, in fact, but the Reg. Guide does not preclude the licensee from developing more specific models for specific breaks. For example, if a break occurs inside of a concrete confinement, there may be very good reasons for them to go to that extra effort.

The CASINOVA source term analysis is somewhat whimsically named. Its intent is to look at the distribution of possible break locations and what volumes and types of insulations would be impacted by those breaks.

Again, it's subjected to the limitations we've already discussed, spherical zones of influence which are specific to the insulation types, and they are now specific to the location within the plant.

It's a stochastic model that runs through thousands of postulated breaks and generates statistical information, as shown in the next slides.

Page 11, probably not visible on your

handout, is a zone of influence. If you'll direct your attention to the screen, there is a magenta circle, a sphere, that represents the zone of influence for fiberglass insulation from a very large pipe break.

MR. ROSEN: Can you stop your red dot and show us where the pipe break is?

DR. LETELLIER: At the center of the sphere. If you can imagine the containment volume superimposed, you can see that the volume of this sphere is at least 30 percent of the total containment volume. Obviously, this region extends well beyond any concrete structures that might redirect the jets, but, unfortunately, we don't have predictive models for that sort of behavior that let us assess this in a parametric way.

DR. FORD: Bruce, coming back to the question I asked earlier, you've got there quite a specific deterministic line. Is it based on data? Somebody has set off a water jet at a simulated stop there and has come up with data to show that that line has reality?

DR. LETELLIER: Not in a plant-specific way with the full geometry. The data that has been obtained has been conducted in the context of free jet expansion, where a pressurized jet impinges on an insulation blanket at some distance down the center line, the jet center line.

DR. FORD: Okay. And whether that insulation breaks away has got to do somehow as to how it is put on and how it is fixed on, and all those are variables that go into the model?

DR. LETELLIER: Yes, that is correct. The orientation of the jacketing, the types of bands that have been used, all of these have been investigated over the years.

CHAIRMAN WALLIS: If you washed on this side of your car with a garden hose when it's covered with salt and sand, you would be very unwise to assume a spherical sphere of influence. If you don't hit that stuff directly, it doesn't come off.

DR. LETELLIER: Again, the limiting assumption here is that the pressure contour, the pressure needed to induce damage has been remapped from a free jet into a sphere.

CHAIRMAN WALLIS: I could see some licensee coming back with a much more -- saying, "You're far too conservative" -- a much better model which says that only 1 percent of insulation comes off.

DR. KRESS: Yes, but then you're going to ask them about rebound effects and deflections.

DR. FORD: But coming to Sanjoy's question earlier on, does it matter? Are we picking at a spot here that doesn't need to be?

CHAIRMAN WALLIS: Well, it does matter. With that much insulation, you don't clog the screen.

DR. FORD: Well, Sanjoy's question was, what's the rate-limiting step to all this, and maybe this is not the rate-limiting step. Is that true or not?

DR. LETELLIER: Again, we had the luxury of demonstrating a minimum level of concern. Now, whether for better or worse, the burden of proof is on the industry to develop high-fidelity models for specific breaks.

For example, if, through a parametric evaluation, a particular region of containment was identified to contain the highest concentration of insulation or the most problematic types of insulation, perhaps it would be to their benefit to develop high-fidelity physics models for that region.

But the NRC has a long history of requiring empirical evidence to support models of that type. So in almost every case the cheaper solution will be to assume a conservative damage volume.

For example, in the extreme, to say 100 percent of insulation in containment, that, in fact, was assumed by the BWR industry, where rather than arguing about what fraction would be damaged, they designed their mitigating systems to accommodate all of the insulation in containment.

DR. BANERJEE: I suppose it depends on whether it's all fiber and particles, because that probably isn't possible if it results in particles. It would be tough, I would think.

DR. LETELLIER: That's true. There will be limitations to the engineering solutions for this problem.

DR. BANERJEE: Now what type of insulation provides these fibers? Is it fiberglass?

DR. LETELLIER: Essentially, very similar to the fiberglass you have in your homes, although qualified for the environment of a nuclear reactor over a long service life.

CHAIRMAN WALLIS: So it costs a hundred times as much as if you bought it in a hardware store?

MR. ROSEN: At least.

DR. LETELLIER: In deference to our industry representatives, I didn't want to say that.

But, essentially, it's very familiar material. In fact, the debris generation -- or, I'm sorry, the debris transport tests that we've conducted, we've taken blankets of this material, run it through a common leaf shredder to generate flocks of a characteristic size, and it's very familiar.

DR. BANERJEE: The only thing worse than a chemical plant is leaves. Large accidents occur when there were constrainers. It was very common.

DR. LETELLIER: You're referring to debris types that transport as platelets?

DR. BANERJEE: Yes.

DR. LETELLIER: Small fragments like a paint chip?

DR. BANERJEE: Yes.

DR. LETELLIER: The debris transport tests that we conducted in the linear flume showed that paint chips do not transport. I don't remember the exact velocity, but it takes an incipient flow velocity in excess of one foot per second, which is not a common condition for the containment pool. So those chips are most likely to settle out and remain in place.

DR. KRESS: They orient themselves in such a way that the flat side is below the stream flow.

DR. LETELLIER: That's correct. They're very difficult to lift, once they've reached the floor. The one exception to that is for plants that have a sump, a horizontal sump configuration very close to postulated break zones, where the material could be deposited directly onto the screen. There are some configurations of that nature.

Very quickly, back to the stochastic model, you can look at thousands of postulated breaks, look at the range of debris volumes, their locations, and relate them back to the exact insulation types that were involved. These are just illustrative figures, not to be digested.

Again, here's the range of projected debris volumes for fiberglass. You will note that the potential volumes are quite high.

CHAIRMAN WALLIS: This is volume of equivalent solid or is this volume of --

DR. LETELLIER: This is volume of fiberglass insulation, assuming the "as fabricated" density.

CHAIRMAN WALLIS: Not divided by the density of glass or it's the --

DR. LETELLIER: The "as fabricated" density, right.

MR. ROSEN: Thousands of cubic feet?

DR. LETELLIER: From a large break potential.

DR. BANERJEE: But I don't quite understand what this --

DR. LETELLIER: This is simply, the results of the simulation looked at postulated breaks in every linear foot of piping in the plant. Based on the size of the pipe and the insulation in that zone, a debris volume was generated for each postulated break.

Now over the range there's a distribution from high to low. You can see that the 95th percentile is pointed out on the figure to be somewhere in the range of 1700 cubic feet.

DR. BANERJEE: But what do you mean by "cumulative fraction" of possible breaks?

DR. LETELLIER: Well, there were 45, on the order of 4500 breaks postulated. So each break has an associated volume. The proportion of events that's related to the debris volume is shown here in a cumulative way.

DR. FORD: This could never happen? You wouldn't --

DR. KRESS: Ninety-five percent of the

breaks have less volume than that.

DR. LETELLIER: That's correct.

DR. BANERJEE: So which are the ones which have the very high?

DR. LETELLIER: Very high?

DR. BANERJEE: Up at the 2,000 level.

DR. LETELLIER: The largest breaks in the largest pipes generate the largest volumes.

DR. BANERJEE: And where is that little plateau? What type of breaks are those?

DR. LETELLIER: Well, this actually represents a jump in the range of piping sizes. There's a large amount of small piping which leads to small volumes, and there's a substantial amount of large pipes which lead to large volumes. But there's a gap in the piping size; for example, from 8 inches to 24 inches. That's what the plateau represents.

DR. KRESS: Yes, and if you want to do a PRA with initiating events for pipe breaks, you have to de-convolute this in terms of pipe size?

DR. LETELLIER: That's correct. If we were to propagate this information through a PRA, we would assign an initiating event frequency to each of these postulated breaks.

DR. KRESS: To each of these. To each of

these.

DR. LETELLIER: That's correct.

One of the items specified in the guidance is to look for breaks that generate the highest ratio of particulate-to-fiber insulation. That's not an immediately obvious question, how you would answer that question. But from an analysis of this type, it pops out very clearly, and it can be related to a specific location within the plant.

These are simply the number of postulated breaks that lead to a given ratio. It's a frequency histogram, nothing more.

But there are breaks that lead to a very high ratio of particulate-to-fiber, and we would have to go and look at this specific plant to find those locations.

MR. ROSEN: Is that a bad thing, a very high ratio of particulate to fiber?

DR. LETELLIER: Those are the conditions needed to create a thin bed effect on a screen, and we'll look at some head loss tests in a moment.

DR. BANERJEE: What is that big peak in there?

DR. LETELLIER: In this particular simulation, with an assumed insulation application, some fraction of fiber, some fraction of particulate, there are a large number of breaks that lead to a very high ratio. For the most part, if I recall, these are small pipe breaks.

DR. BANERJEE: Now it's not just the ratio that matters, but then there must be an absolute number that's important, like either the particulate or the fiber. If that ratio is high but you have no fiber, it doesn't really matter.

DR. LETELLIER: That's true, there is a minimum fiber that's needed, but the current thinking is that there may be enough fiber resident in the PWR containment, regardless of how much is generated in the break.

DR. BANERJEE: I see. Like hairs or something?

DR. LETELLIER: Hairs, clothing, fiber. Remember, these containment buildings are open for long periods of time during refueling. So you have ambient dust loadings, material tracked in and out.

For the most part, they are very clean by industrial standards, but if you look, you will find resident particulates and fibers.

The next section talks about debris generation in the zone of destruction. I think we'll move very quickly through this. The verbiage in the guidance is listed on page 16.

Some additional detail about the zone of influence is provided on page 17.

CHAIRMAN WALLIS: Now this is, again, as we talked about, this is so many L/Ds? The scale there is in units of one L/D? So at three L/Ds, you go out for a certain zone, and then six for the next, and then --

DR. LETELLIER: Yes, those zones are intended to represent the damage --

CHAIRMAN WALLIS: Those are actually units of L/D? Do you specify those somehow? There's no unit on the axis there.

DR. LETELLIER: But if you count the number of tick marks, you can see that on this axis there are seven units.

CHAIRMAN WALLIS: Each tick is an L/D?

DR. BANERJEE: That's more representative than the actual debris --

CHAIRMAN WALLIS: Then the other axis which is coming out is misdrawn? It should be the same as the others?

DR. LETELLIER: That's correct, it's lost in the perspective.

CHAIRMAN WALLIS: Then, just to point out, in this Draft Reg. Guide there's a reference to Figure 2-A about this same sort of thing, which isn't here. It's missing somewhere.

DR. LETELLIER: I do not have that figure that's referenced.

CHAIRMAN WALLIS: There's a wrong Figure A-2. Figure A-2 is a sump screen schematic, and yet the text refers to an A-2 which must look something like that?

DR. LETELLIER: It looks very much like this, but the intent of that figure is to show the size distribution of the debris that's generated from a specific insulation type.

MR. ROSEN: I'm sure this picture had a color code that doesn't come through. It says, "zone of influence for fiberglass," like a legend up at the top, and then I don't know which one it refers to.

CHAIRMAN WALLIS: The inner one, presumably.

MR. ROSEN: Bruce says the outer one.

DR. LETELLIER: If I could explain --

CHAIRMAN WALLIS: The insulation is probably the middle one.

DR. JAIN: The outer one is fiberglass.

The middle one is Calcium-Silicate, and the other one is RMI.

CHAIRMAN WALLIS: So at three L/D, you've attenuated so much that you don't need any more --

DR. JAIN: We do not read this figure to represent what those numbers are.

CHAIRMAN WALLIS: Well, it's an effective volume, first of all. So you may actually be affecting stuff the other way.

DR. JAIN: It could be L/D equal to 10 or 11 or 12. It's more a schematic to show there are different zones for different materials.

CHAIRMAN WALLIS: So what happens if this sphere intersects the boundary of containment?

DR. LETELLIER: At the moment we're not assuming any sort of reflection or deflection.

CHAIRMAN WALLIS: You just bounce it off and still have the same volume?

DR. LETELLIER: In fact, we have not gone that far either. We're assuming it's truncated. There has been a lot of discussion about whether that assumption is conservative or non-conservative, and it depends greatly on the exact break location.

DR. BANERJEE: I'm still having problems with this sphere. Maybe there's something I'm missing here.

DR. LETELLIER: The zones, the concentric zones, are intended to show the damage pressures, the vulnerabilities of each insulation type from the most vulnerable to the most robust. The outer zone for fiberglass relates to a damage pressure of about 10 psi, which has this radial extent. The inner zone is for Calcium-Silicate, and for this figure I'm not sure exactly what damage pressure it is, but it is more robust. Finally, reflective metallic insulation is the most robust and has the smallest damage level.

DR. BANERJEE: Does this mean that if I -- let's say there's a pipe which breaks and the bed of origin is there. If I have a pipe, say, within a distance which is between that for the fiberglass and the Calcium-Silicate, then whatever fiberglass insulation is on it will become debris? But for that we need to actually put L by D, like saying this is the distance or something, right?

DR. LETELLIER: That was the purpose of the CASINOVA model, was actually to look at the geometry, the arrangement of insulation relative to the break.

DR. BANERJEE: Right, but you don't take the jet, details of the jet into account. You just say it's within this sphere of influence.

DR. LETELLIER: That's correct.

DR. BANERJEE: And then you just disintegrate all of that?

DR. LETELLIER: Into a range of sizes, to a range of debris sizes. That range is described by the three zones in this missing figure.

DR. BANERJEE: Right. So you take the probability of that jet being in different directions into account in doing that?

DR. LETELLIER: Essentially, we're assuming that it's equally probable in any direction.

DR. BANERJEE: Okay, let's say there's a probability of a break of this size at this location. Then once you've established that probability, you're saying it could be the probability is equal in all directions, but then do you take that, divide by the circumference or something, or what? What do you do?

DR. LETELLIER: Keep in mind that your reference to probabilities is hypothetical. We have not propagated this sort of information through the risk assessment. It is implicit in the use of a spherical model that the jet can be directed in any direction, but we are not incorporating that into any sort of risk analysis.

DR. BANERJEE: So you don't assign a probability to this?

DR. LETELLIER: That's correct.

DR. KRESS: This is all strictly deterministic.

DR. LETELLIER: That's correct.

DR. BANERJEE: Yes, okay.

DR. RANSOM: That introduces some conservatism then, I guess. You assume everything within this zone is destroyed or broken up into the particles, right?

DR. LETELLIER: That's correct.

DR. RANSOM: Whereas, in reality, the jet may only break up something in a smaller zone of influence?

DR. LETELLIER: But what we have preserved is the volume of potential damage.

CHAIRMAN WALLIS: Is there any evidence that this is reasonable?

DR. KRESS: It's empirically-based.

DR. LETELLIER: I don't know that it's substantiated by empirical evidence, but it is, and has been, the common accepted practice for the BWR vulnerability assessment, for example.

DR. FORD: And they didn't have data to

back those assumptions, just about how conservative they are or --

DR. LETELLIER: They did not have geometry specific for information about jet deflections, for example. They did extensive tests on destruction pressures of different debris types. There is a correlation in NUREG-6224 that allows for some adjustment for pipe separation, what the separation distance is and also the displacement.

Whether they are fully separated and fully displaced, that could lead to opposing cones. If they're not displaced but they are separated, that could lead to impinging jets. That makes the spherical proximation not an unreasonable thing to assume.

DR. FORD: Again, how dependent are you -- it's a huge assumption which is not based or backed up with any data, apparently? So what's the down side of that.

DR. LETELLIER: Well, the alternatives, of course, are to use a model like CASINOVA to introduce some of the directional effects like a fishmouth break that generates a single cone in a random direction, and we can do that. But, again, you'll be faced with the same limitation.

It's not substantiated by data. It is a plausible mechanism, and we could look for important differences, but, again, it won't be a highly faithful representation of actual events.

DR. RANSOM: Well, the L/D limits that you're using in this representation I assume are derived from data that you've taken where you've shot, broke a pipe and had it shoot at directly some insulated component, I guess, right?

DR. LETELLIER: That is correct. And on the next figure is a more quantitative representation of this information.

DR. KRESS: Before you go to the next figure, I'm intrigued by your description of the guillotine break separating, which would form two cones. It seems to me like the conservative assumption would be, if that happens, you take twice this volume, because each cone is going to take out its fraction of the debris.

DR. BANERJEE: At half the pressure though. There's only half the flow. I mean he's looking at impact pressure.

DR. KRESS: I don't think so, because it's just a cone expanding out and you calculate that pressure.

DR. LETELLIER: The correlations do account for that effect because they are a function of both separation and displacement, and I'm not personally familiar --

DR. KRESS: Is there some sort of correlation in there that accounts for that?

DR. LETELLIER: Yes, there is.

DR. KRESS: Okay. So you'll get a different zone factor --

CHAIRMAN WALLIS: When you say, "L/D," is that the pipe size or the break size, the "D"?

DR. LETELLIER: The length is the radius away from the break --

CHAIRMAN WALLIS: What's the "D"?

DR. LETELLIER: -- compared to the pipe diameter.

CHAIRMAN WALLIS: So it's really the break size?

DR. LETELLIER: Yes, assuming a guillotine break.

CHAIRMAN WALLIS: So for a double-ended guillotine break, is it square root of two times the diameter?

DR. LETELLIER: No, it's correlated to the diameter, actually the physical diameter of the pipe.

The next slide, page 18, shows some more quantitative information, so that you have an impression of what the various vulnerabilities are. Higher damage pressures imply a more robust insulation application.

DR. FORD: And this is based on just firing a jet at some things in the laboratory?

DR. LETELLIER: That's correct. Unprotected fiberglass is perhaps some of the most vulnerable material, having damage pressures in the range of 6 to 10 psi.

DR. KRESS: Is old insulation worse than new insulation?

DR. LETELLIER: I can't comment on that. There are aging effects that affect the friability of this material. We have to look at other documents to answer that.

DR. BANERJEE: So Min-K is fiberglass? What is Min-K?

DR. LETELLIER: Maybe I could call on some industry help. Min-K is --

MR. HART: It's a microporous insulation.

DR. LETELLIER: It's a microporous insulation.

CHAIRMAN WALLIS: What does that mean?

Does that mean it's fiberglass?

MR. HART: No, it's microporous. It's a very low turbo conductivity material made of tiny -- take a look at the exhibit -- formed into a thin mat, and they're hollow on the inside.

DR. LETELLIER: In the same category as Calcium-Silicate, which is a low-density, a low-thermal-conductivity material.

MR. HART: Yes, Calcium-Silicate is made from diatomaceous earth. Under the microscope it looks like a lot of little planktonic --

DR. LETELLIER: It represents a class of insulation.

DR. BANERJEE: So the Min-K is microporous silica or what? What is the material? What is the chemical composition of that?

MR. HART: I'm not certain.

CHAIRMAN WALLIS: It's not really Calcium-Silicate which is key here. I mean it depends on how it's bonded. You have these little whatever you called them --

MR. HART: Planktonic.

CHAIRMAN WALLIS: -- planktonic things, but if they're not bonded together, it's not going to have this 160 psi resistance.

DR. LETELLIER: No. In fact, the robust nature of the Calcium-Silicate with the aluminum jacket was actually viewed to be a limitation of the existing BWR data. That's one of the reasons that we requested a test program, in cooperation with Ontario Power Generation, on the next figure.

MR. ROSEN: On that previous figure, is there any thermal lag in these containments?

DR. LETELLIER: I'm not sure the nature of your question. Obviously, there's thermal inertia. For what reason --

MR. ROSEN: Thermal lag, no. There is, and I didn't see it on this list. Is it a bad actor or a good actor?

DR. LETELLIER: I can't comment on that.

MR. ARCHITZEL: Fire-barrier materials, this is insulation material, I guess, is what we're dealing with here, but the fire-barrier material was also assumed to be looked at, but this chart here is just dealing with insulation material.

DR. LETELLIER: And, again, I would repeat that the test programs have never been intended to be comprehensive for every material type.

MR. ROSEN: But there's fire-barrier materials in containments, and they would be blasted apart, too.

DR. LETELLIER: Yes, they would.

DR. RANSOM: What are the units of these pressures?

DR. LETELLIER: Psi, stagnation pressure --

DR. BANERJEE: They're really impact pressures you're talking about.

DR. RANSOM: Is that taking all the velocity head out at that point, putting the thing there, and boom. Is that how you -- how do you measure that pressure?

DR. LETELLIER: I'm not personally familiar with the diagnostics of the jet pressures. They are intended to represent the stagnation pressure on an object, on an unyielding physical object.

CHAIRMAN WALLIS: My intuition says, if I take some household fiberglass and wrap a piece of pipe with it and direct a garden hose at it, it won't come off, and the pressure there is probably 40 psi.

DR. RANSOM: These must be one-half r-squared, I assume. Otherwise, they would be at least the containment pressure plus.

DR. BANERJEE: But if you put fire hose water on it, it probably will --

MR. SNODDERLY: Excuse me, Bruce. This is Mike Snodderly.

I notice we're on slide 18 and you have 48 slides that you would like to present.

CHAIRMAN WALLIS: There can't be 48. Are there really 48?

MR. SNODDERLY: Forty-four, sorry. What I would like to suggest is maybe we could take a few minutes just to maybe try to prioritize what we want to try to look at between now and, say, 4:30, quarter of 5:00, because I want to make sure that we give John Butler and NEI an opportunity to let the Committee know what they're doing.

For example, I notice that, when I read through the Reg. Guide, one of the big analytical models that jumped out at me was under "debris transport," 1.334, an acceptable analytical approach to predict debris transport was NUREG/CR-6772 and 6773. I noticed that your slide 31 goes over those assumptions. So I think the Committee would be very interested in going over that.

Obviously, I think they would like to have some understanding of the debris transport chart, the work that you show in slides 27, 28, and 29.

So I would like to put it to suggest to

you, what do you think, to get to the point where in your conclusion, where you say, "These are the acceptable analytical models that we believe exist today," and the basis for them, and maybe summarize.

Does that sound fair, Dr. Wallis, or what do you think?

CHAIRMAN WALLIS: Well, I'm just thinking that this is all fascinating stuff, and we could go on all day, but I'm not sure it makes any difference to the conclusion. I mean this Reg. Guide can go out for public comment whether or not any of this makes any sense, because someone's got to do the analysis. This really requires it.

If we're going to have to review whether or not we believe your analysis, that's a whole different kettle of fish.

DR. LETELLIER: I think the purpose of this talk is to demonstrate that methods have been offered and that there is a technical basis to support the Reg. Guide.

CHAIRMAN WALLIS: There's no way that in this meeting we're going to bless these methods. We need to study the NUREGs and all that.

MR. SNODDERLY: Right, you're right, Dr. Wallis. The purpose is just to determine whether they're sufficient to be released now for public comment.

I think what I would like to accomplish is for the Committee to have as good an understanding as possible in the time remaining of what the methodology is that the staff has developed. So that when we hear from NEI, we can get an understanding of their analytical approaches or where they plan to go.

Then, again, as the Reg. Guide goes out and public comment occurs, when it comes back to us, we'll have some idea of what the state-of-the-art of the analytical methods are and where they'll go, and perhaps we can have some input into that.

CHAIRMAN WALLIS: Well, Mr. Butler is here, is he?

MR. BUTLER: Yes.

CHAIRMAN WALLIS: Would you be willing to stay later? If we go on for another half-hour with this, would that be all right with you?

MR. BUTLER: That's fine.

DR. LETELLIER: The questions of the Committee have been very relevant, and you have anticipated much of the presentation material. So if there are areas you would prefer to focus on, please let me know.

Continuing a little bit more quickly with slide 19, we did attempt to remedy the deficiency in Cal-Sil data by starting a research program with Ontario Power Generation. They had a test facility of a limited volume --

MR. ROSEN: You might want to click the slide. You're on 18.

CHAIRMAN WALLIS: Yes, let's move along now.

DR. LETELLIER: Thank you.

The test conditions are listed in the upper righthand corner. It was a small-volume tank with a fixed nozzle opening and an initial pressure somewhat lower than a PWR blowdown condition at a temperature somewhat lower.

The blowdown history from the test apparatus is shown in the lower curve, the red curve, and predictions --

CHAIRMAN WALLIS: Of course, RELAP is perfect.

DR. LETELLIER: Thermal-hydraulic predictions of the PWR are shown in black.

CHAIRMAN WALLIS: Oh, I thought it was the red one.

MR. ROSEN: The testing must be wrong.

CHAIRMAN WALLIS: I thought it was the red one.

DR. KRESS: What is the vertical axis? I can't read it.

DR. LETELLIER: These are pascals.

DR. KRESS: Pascals?

DR. LETELLIER: The pressure versus time.

CHAIRMAN WALLIS: I thought the RELAP prediction for the test set was perfect.

DR. KRESS: It is.

CHAIRMAN WALLIS: Yes, so let's move ahead.

DR. LETELLIER: I'm illustrating the difference between the test configuration and the actual PWR blowdown, and the motivation for actually scaling the debris generation data for the effects of --

CHAIRMAN WALLIS: They direct this yet at a typical pipe?

DR. LETELLIER: That's correct.

And a couple of figures are shown, photographs, in pages 22, 23, and 24.

CHAIRMAN WALLIS: It's a before and after picture?

DR. LETELLIER: Yes. The basic

conclusions are shown on page 21, which emphasizes that the OPG data had to be rederived or modified to account for the actual PWR accident condition.

The conclusions show a slightly increased zone of influence compared to damage zones derived in the BWR study. Again, for this accident scenario, we have a two-phase jet blowdown with important momentum effects in the droplets.

Zone of influence increased slightly for both Nukon and Cal-Sil, and we observed a higher fraction of small material or fines compared to earlier tests.

CHAIRMAN WALLIS: Are you going to show us the before and after very quickly?

DR. LETELLIER: Page 22 is the test item as applied in a jacketed fashion.

CHAIRMAN WALLIS: It's blasted head-on by a jet?

DR. LETELLIER: That's right, on the center line. It's positioned on the center line.

DR. RANSOM: Is that the jet over on the left side?

MR. ROSEN: The jet comes in perpendicular to that.

DR. RANSOM: Well, that orange thing over there, is that a nozzle?

DR. LETELLIER: One of these two pipes represents the nozzle. I'm not sure which one.

MR. ROSEN: The one below will miss it.

DR. LETELLIER: The perspective is difficult to see in the photograph. I believe this test article is positioned on the jet center line.

MR. ROSEN: There's an arrow there on the line, isn't there?

DR. RANSOM: That's the target.

MR. ROSEN: That's the target, I should say.

DR. RANSOM: I see, "X" marks the spot, right?

MR. ROSEN: It sure looks like it hit the spot.

DR. LETELLIER: You will also notice the orientation of the jacketing, so that the overlap on the stainless steel jacket is exposed to the jet. That represents a condition of vulnerability as opposed to rotated or oriented away from the jet.

This is a Calcium-Silicate blanket. Again, the nature of this insulation is basically low-density concrete. It has a very low thermal conductivity. It's very easy to mold and apply in different configurations.

After the test, you can see the extent of damage.

CHAIRMAN WALLIS: And then you collected all the pieces.

DR. LETELLIER: And then they collected the pieces, and that's shown on page 24, at least the range of debris that could be recovered. The remainder that was not recovered is assumed to be in the fine, very transportable fraction, and a crude mass balance was attempted to proportion --

MR. ROSEN: It's in Lake Ontario.

DR. BANERJEE: How much of it went into fines compared to the total mass?

DR. LETELLIER: If we look back on slide 21 --

DR. BANERJEE: Oh, it's there? That's fine.

DR. LETELLIER: Slide 21.

DR. BANERJEE: You don't have to go back.

DR. LETELLIER: Approximately 30 percent of the material was generated in fine debris. Prior to this study, there had been no observed damage for Cal-Sil in jacketed configurations. We felt that those tests had been flawed, and so that's the reason we attempted to gain more empirical evidence.

DR. BANERJEE: Now this facility of Ontario Hydro or Power Generation is available for other tests as well or just --

DR. LETELLIER: We actually had a quite extensive test program planned with them, but we weren't able to conduct it to fruition because of some safety concerns with their thermal-hydraulics lab. So it was not made available to us as freely as we hoped.

DR. RANSOM: I notice some of the data, the fields of damage were like 12-D and you were using 7 as the limit before. How do those two compare?

DR. LETELLIER: I'm not sure what you're --

DR. RANSOM: Well, on slide 21 you have slightly increased zone of influence, 12-D versus 10-D, and before you were quoting 7-D, I thought, as the maximum L/D.

CHAIRMAN WALLIS: It's the affected sphere, though, isn't it?

DR. LETELLIER: Again, that sphere was meant as a representation to explain the vulnerabilities of different insulation types. I wouldn't try to relate it quantitatively.

DR. RANSOM: What values are used, then,

I mean in your calculations? Are they the ones that you obtained from these experiments?

DR. LETELLIER: Yes.

DR. RANSOM: Okay.

DR. LETELLIER: Yes, the destruction pressures are based on observation. That's the only basis that we have.

To clarify, there is no predictive model of microphysics for debris generation for an impinging jet.

DR. RANSOM: Sure. Well, I was wondering where the value 7 came from that you talked about before.

DR. LETELLIER: I was simply counting the tick marks on the graphic.

DR. RANSOM: Okay.

DR. LETELLIER: Yes, it was meant as a representation.

CHAIRMAN WALLIS: Yes, but somebody has to put numbers on it if they're going to calculate anything.

DR. LETELLIER: And that has, indeed, been done in a tabular way.

Moving on to blowdown/washdown on page 25, again, we have no truly predictive model to determine where this debris will go.

CHAIRMAN WALLIS: Well, the containment spray does a pretty good job of washing it down, doesn't it?

DR. LETELLIER: Yes, it does, but it is also true that it does not impinge on every vertical surface. There are significant fractions that are sheltered from direct spray, and in that case you have steam condensation in rivulet formation that can wash debris to the floor.

Because we have no predictive capability, we are looking at the conditions necessary for transport, the updraft velocities, for example, and the impingement of containment spray. We're looking at the water balance calculations provided by our volunteer plant, looking at the hold-up in pools on each floor of containment, and where the most likely return paths are; for example, stairwells and designed drainage features.

This information is being incorporated into a logic chart, very much like an event tree for an accident analysis, where we try to make defensible, conservative decisions about the fraction of each size of debris type that's either retained --

CHAIRMAN WALLIS: It seems to me you have no basis for it whatsoever. I mean, if you look at a stairwell and you try to predict how many of these rocks stop on the treads of the stairs, you can't do it just by talking about it like this.

DR. LETELLIER: There is actually empirical evidence of retention by gradings, actual debris --

CHAIRMAN WALLIS: So you put in actual numbers here?

DR. LETELLIER: Where we have information, of course, we do, and where the information is lacking, we make conservative assumptions. As I pointed out earlier, the retention factors are less than 50 percent.

CHAIRMAN WALLIS: At least it gives you a framework for filling in.

DR. LETELLIER: It does, and as I tried to make a list here, it lets you assess the degree of conservatism that can be compared to the plausibility of these physical mechanisms.

This is on Figure 27, which is a schematic of the logic chart, but in the next two pages, 28 and 29, you can see that you can get carried away with this level of detail.

CHAIRMAN WALLIS: It's the debris that

gets carried away.

(Laughter.)

DR. LETELLIER: Touche!

CHAIRMAN WALLIS: Wow, it's an eye test (referring to the chart).

DR. LETELLIER: This type of analysis is very easy. The PRA tools have been adapted to look at the various transport mechanisms.

CHAIRMAN WALLIS: Okay.

DR. LETELLIER: Please don't spend any time studying this. It's simply an illustration.

CHAIRMAN WALLIS: Yes.

DR. BANERJEE: But do you actually use something like this?

DR. LETELLIER: We are actually using this to assess its value for our volunteer plant analysis. We're trying to --

DR. BANERJEE: Do you think this level of detail is appropriate? I mean, it's like having too many significant figures in a number.

DR. LETELLIER: Well, as I said, we've already learned the key element.

DR. BANERJEE: Right.

DR. LETELLIER: We've discovered that we cannot rationalize a reduction factor of more than 50 percent. It's not a factor of a hundred or a thousand, as some people would like to claim, actually, that the fine particulates will be carried to every surface in containment, and they will never come down. We cannot rationalize that from a conservative engineering perspective.

DR. BANERJEE: But do you need this level of detail to do that?

DR. LETELLIER: The answer is no.

DR. BANERJEE: I mean, is this illustrative or it is something which is in some NUREG that somebody can attack and say, "This doesn't make any sense."?

DR. LETELLIER: This is illustrative and it's also educational, if you will. It lets the plants prioritize where to put their analysis effort.

MR. ROSEN: You know, it's not that educational to me because I can't read the event states at the top. Would you just sort of read a few of them to me, so I know what they say?

DR. LETELLIER: Let's go back to the schematic.

CHAIRMAN WALLIS: He can't read it, either.

(Laughter.)

MR. ROSEN: Which one are you looking at? Right now you're --

DR. LETELLIER: This is on page 27.

MR. ROSEN: Well, you've got page 26 up there.

DR. RANSOM: It's slide No. 27.

CHAIRMAN WALLIS: So there's bullets would appear as stages in this tree diagram?

DR. LETELLIER: It basically walks you through the disposition of a debris fragment depending on its size, whether it's initially deposited on the floor, on a vertical surface, on a horizontal surface; whether it's impacted by sprays, direct impingement, or condensation; whether it is subject to secondary motion through pools on elevations, different elevations of the plant, and, eventually, whether it's deposited into the pool.

MR. ROSEN: And that's what this ghastly one does?

DR. LETELLIER: That's the end state.

MR. ROSEN: It takes it from one step to another to another, to a third perhaps --

DR. LETELLIER: That's correct.

MR. ROSEN: -- and, ultimately, down into the sump?

DR. LETELLIER: That's correct.

DR. BANERJEE: So you've done more details of each of these?

DR. LETELLIER: Yes. And what we've learned by this exercise is that there's not a great return to be gained by the plants investigating this in detail.

For example, you mentioned earlier, if you did a full computational fluids model of a break jet in a specific location, you might argue that there was very little debris generation for a particular break. I don't think you could get the same savings in this aspect of the accident sequence, largely because of the uncertainty in the initial conditions. You physically just don't know where every piece of debris will go.

You can talk about it generically, and you can argue it conservatively, but, ultimately, as we sum up all the end states in this event diagram, we see that between 70 and 90 percent of the debris eventually comes back to the pool.

MR. ROSEN: Well, it's a great simplification.

CHAIRMAN WALLIS: Then let's design for a hundred percent and forget about it.

MR. ROSEN: Yes, it makes sense. It's very valuable. It's a great simplification. You don't have to trace each particle's path. You know where it started and you know where it's going to end. You're not that interested in what it does in between.

DR. LETELLIER: But the key point is we needed to perform this exercise to reach that conclusion. Now it's available for the industry's evaluation.

Moving on to pool transport on page 30 and 31 --

DR. BANERJEE: So are you going to say in the Reg. Guide or is one of the accepted things going to be, if you say 80 percent is going to get down, fine; if not, do you prove that below whatever this --

CHAIRMAN WALLIS: If they can't prove it, they're supposed to assume 100 percent, aren't they?

DR. JAIN: That's what we have in the Reg. Guide right now.

DR. LETELLIER: That default position is stated in every aspect of the accident scenario in the Reg. Guide.

CHAIRMAN WALLIS: Okay, can you move along quickly through this one?

DR. LETELLIER: Certainly. For pool

transport, we were very concerned about debris mobility in the pool.

CHAIRMAN WALLIS: Yes, because it hides in corners. It hides in stagnant areas.

DR. LETELLIER: It does. There is a potential that it may.

Initially, we needed to characterize the mobility of debris types, whether it's a paint chip or a crumble of foil or a flock of fiber that's one inch or five inches. So we conducted a separate effects test in a flume to look at incipient flow velocity, settling rates, et cetera.

The second phase of analysis was to introduce this debris into an integrated tank. It was a scale model, a one-tenth scale, of a PWR configuration. We looked at the disposition of debris both during fillup and also at the recirculation phases.

It was difficult to preserve momentum scaling in this study, so we looked at it as an integrated test that introduced rotational flows and opportunities for settling.

In fact, we did collect debris on both a vertical and a horizontal screen, and the most important conclusion was that, perhaps not surprising, is that individual fibers are indefinitely suspended, and they eventually migrate to the screen.

We also observed that in regions of splashing, where water would return to the pool, there is a degradation mechanism that will continue to shred flocks of insulation that actually reach that zone. That's a very important thing to learn.

MR. ROSEN: Because it floats?

DR. LETELLIER: No, because of the recirculation patterns around a splash, material is actually collected; it's drawn towards that area. An initially large flock of one inch perhaps, which might remain stationary, if it's entrained in the splash, it will be shredded into individual fibers.

CHAIRMAN WALLIS: Something that white water canoers have experienced, too.

MR. ROSEN: Getting shredded?

(Laughter.)

DR. LETELLIER: That's correct. So the primary conclusion of the integrated tank test is that velocity maps and regions of localized turbulence are important to assessing the final transport fraction of debris in the pool.

On page 32 are some computational fluid dynamics results of a splash introduced in one of the steam generator compartments. That gray circle represents splashing water on the floor. We're looking at the velocity maps that are generated to determine whether or not it exceeds the incipient flow velocity for different debris types.

DR. BANERJEE: Is this a plan view?

DR. LETELLIER: It is. It is a plan view at the floor level of a representative of --

CHAIRMAN WALLIS: So you're saying the red area gets scoured? Is that what you are saying?

DR. LETELLIER: That's correct.

DR. KRESS: That depends on the amount of flow going into that splash area?

DR. LETELLIER: Yes, it does, and it's very geometry-specific. That's the other conclusion to take.

DR. BANERJEE: But you just integrated over the height, right? You didn't actually do a 3-D CFD simulation?

DR. LETELLIER: Yes, this is a 3-dimensional pool calculation, and this is the slice at the floor level.

DR. BANERJEE: I see.

DR. LETELLIER: There are representative horizontal velocity components at the floor.

DR. BANERJEE: It seems overkill. But, anyway, go ahead.

MR. ROSEN: So tell me, what does it tell me, all of the orange?

DR. LETELLIER: The figure on the right has been scaled to a maximum velocity of .2 feet per second. From the individual effects test, that's sort of a rule-of-thumb threshold for debris movement. If it exceeds .2, it's very likely to be mobile. If it's less than .2, there's an opportunity for settling.

So you can see that in the cavities opposite the break there is an opportunity for settling, but much of the remainder of containment is turbulent and it will be moving debris.

CHAIRMAN WALLIS: Yes, more than often.

DR. LETELLIER: And that's exactly the perspective that we hope to use. We're not hoping for a predictive capability of debris transport. We're looking at the fractions of containment area that are subjected to potential transport and applying that in a crude way, a 50 percent, a 30 percent --

CHAIRMAN WALLIS: Well, you're also getting expertise with which to review whatever industry gives you.

DR. BANERJEE: Of course, if you had two

sumps now, you would have one in a low-flow and one in a high-flow area, right?

DR. LETELLIER: If they had the luxury of redesigning with forethought, perhaps they would. Every containment design has a single-sump location that's more or less co-located. There are examples of multiple-sump outlets, but they are on one side of containment. They are in one location.

DR. BANERJEE: But both trends start basically from the same area?

DR. LETELLIER: That's correct.

DR. RANSOM: Where is the sump in this case?

DR. LETELLIER: The sump is --

DR. RANSOM: And how deep is the layer of fluid?

DR. LETELLIER: In this simulation I believe it is 24 inches, which is in the range of a plausible pool depth. Again, it is not a perfect scaling, but it's an example of an analysis technique that could be used.

CHAIRMAN WALLIS: Can we move on now?

DR. LETELLIER: The next slide just simply shows the dependence on geometry. The patterns are completely different if the break is in a different quadrant.

CHAIRMAN WALLIS: So you're going to run 10,000 Monte Carlo simulations?

(Laughter.)

DR. LETELLIER: We hope to run four, one for a break in each steam generator cavity, and look at the fractions to decide whether they're substantially different or not.

Slide No. 34 is a simple schematic of how the information from velocity maps and separate effects testing can be combined to estimate an ultimate transport fraction in the pool. Again, these conclusions will be cast in the form of 30 percent, 50 percent, based on the intuition that we've established from calculation.

You can read some of these observations regarding CFD. I would just remind you that we are not attempting to do a predictive model of debris transport. We're not looking at the microphysics of drag, settling, entrainment. We are trying to use this as a tool for velocity maps.

DR. LETELLIER: You're using it like PRA, to gain insights and --

DR. BANERJEE: But you have some experiments, right? I mean, you're not depending on this CFD code?

DR. LETELLIER: That's correct. We've actually run calculations and bench-marked them against our tank tests under the test conditions.

DR. BANERJEE: But, you know, you can make a CFD code fit anything. So you need some experiments.

DR. LETELLIER: That's correct, and we did observe good, qualitative agreement between the models and the tank experiments.

The reason that we're not pushing for, again, the reason we're not trying to develop a predictive capability is captured in the last bullet: The uncertainties in the location and the timing of debris introduction, they just limit the need for high-fidelity modeling. We simply don't know when and where this material will return to the pool.

CHAIRMAN WALLIS: Now this next bit, head loss, ought to be the easiest part.

DR. LETELLIER: From the point of view of testing, I believe that is accurate. There is a substantial amount of information in the literature regarding head loss of various debris compositions, bed thicknesses, et cetera.

In the BWR study in NUREG-6224 that

information was captured in a correlation based on theory for porous media and validated against experiment for the correlation coefficients, for very specific test conditions.

Some of the features of importance are the water temperature for dynamic viscosity, the media, the composition of the bed, its thickness, and the flow velocity through the bed. Those are all important parameters of the correlation.

CHAIRMAN WALLIS: The mysterious one looks like page 40 -- other than what you might expect.

DR. RANSOM: What is "UNM"?

DR. LETELLIER: University of New Mexico.

DR. RANSOM: Okay.

DR. LETELLIER: The Civil Engineering Department has been helping us conduct these tests.

CHAIRMAN WALLIS: What is this page 40? Can you go to that?

DR. LETELLIER: Slide No. 40 is an illustration of the head loss correlation applied over a range of debris volumes, fiber volumes. You can see that there is a sharp transition at low fiber volumes where the bed begins to deteriorate. Essentially, you punch holes in the fiber mat, and the flow starts to escape through the screen. And that's the reason that the head loss does not --

CHAIRMAN WALLIS: It depends very much on the structure of the fibers. Some of them are reinforcing. They squash down and they may get tighter. Other ones open up.

DR. LETELLIER: Bed compaction is --

CHAIRMAN WALLIS: The fibers bend around the screen, is what happens, isn't it, here?

DR. LETELLIER: Yes, that's the effect that you're seeing.

MR. ROSEN: You're going online.

MR. ARCHITZEL: Focus on that slide with the perspective of removing all the fiberglass can still be a problem or can create a problem.

CHAIRMAN WALLIS: This indicates it isn't as simple as you might think. You need more fibers to reduce the pressure?

DR. LETELLIER: There is a counterintuitive behavior where thick beds are actually more porous. Thick beds of fiber can provide more flow area than a thin bed, simply because of the interstitial gaps between the fibers. If they are not compressed, as he mentioned, they will allow more water to pass through.

A very thin mat that's arranged in a very regular fashion, and the interstitial gaps are blocked by particulate, is very effective at ending flow.

CHAIRMAN WALLIS: I think there's a hysteresis with this. I mean, if you have laid down a very uniform bed without holes in it, you get a different curve, and if you begin to build it up and then it breaks down, then you build it up some more. There's a time effect with this whole thing.

DR. LETELLIER: That effect is very evident. I actually deleted a slide that showed that.

The test that we're interested in is taking, for example, a one-inch mat of fiber and gradually increasing the flow velocity so the bed compresses. As we relax the velocity, the bed does not re-expand. There is a hysteresis effect.

DR. BANERJEE: Does this contain any particulate matter as well or just fiber?

DR. LETELLIER: The various curves represent the amount of particulate that is present: 300 pounds, 200 pounds, et cetera.

The qualitative behavior is the same.

DR. BANERJEE: I can't get a feel for what those pounds mean, but is that sort of -- how many feet squared are we on?

DR. LETELLIER: I'm not sure exactly what the conditions were for this calculation. It's offered as a representation of proper use of the correlation. Between 100 and 300 pounds is a reasonable value for particulate in PWR containment, and there's work currently ongoing to quantify that.

DR. BANERJEE: But that would depend on the surface area of the filters, right?

DR. LETELLIER: Very much so.

DR. BANERJEE: Okay.

DR. LETELLIER: The head loss effect depends greatly on the surface area.

CHAIRMAN WALLIS: Okay, can we move on?

DR. LETELLIER: I think that you've gotten a good impression of the detail to which we have examined the various aspects of the accident sequence. Ultimately, each component has to be integrated into a vulnerability assessment from beginning to end, that is, from debris generation to ultimate head loss.

The final slides on page 42 illustrate some of the tools that LANL has used to gain insights into these effects and the methods that are being offered to the industry as a starting point for their own analysis.

In particular, I would point you to bullet two, the Knowledge Base Report, which is forthcoming, is a compilation of all existing test data and analysis methods.

Bullet 3 is a comprehensive plant analysis which is currently ongoing to help us gauge appropriate level of detail and help us assess the validity of plant responses to the Generic Letter.

CHAIRMAN WALLIS: If every plant had to do as much work as you've done, it would be much cheaper just to make a bigger screen.

DR. LETELLIER: Certainly, but, actually, I don't think the NRC would have been comfortable making that judgment unless we had gone to this level of detail.

DR. BANERJEE: But would a bigger screen work if there was a lot of fiber? I mean, that's really the bottom line here.

DR. LETELLIER: Of course, there are limits to engineering solutions.

DR. BANERJEE: Right.

DR. LETELLIER: And if they simply don't have space, they will have to take advantage of other concepts. For example, in the BWR screens, they arranged stacked disks or crenelated surfaces to allow for perpendicular flow components. The bulk flow moves in one direction; the filter draws flow in a transverse direction, and that establishes a very low penetration velocity, which in turn gives you very low head loss.

So there are important design considerations that should be incorporated into --

CHAIRMAN WALLIS: Is it a fluted type of screen?

DR. LETELLIER: I'm sorry?

CHAIRMAN WALLIS: A fluted sort of screen?

DR. LETELLIER: You can imagine different geometries.

CHAIRMAN WALLIS: Folded screen?

DR. LETELLIER: Yes, folded arrangement, stacked disks. Your imagination is the only limit.

I would point out one important difference between -- the BWR screens are primarily perforated plates. They have circular openings stamped into stainless steel. PWR screens are primarily wire mesh, rectangular wire mesh arrangements.

The head loss testing that we performed demonstrates that the correlation is applicable to both configurations, and we are refining the coefficients of this correlation to apply, best apply, to Calcium-Silicate, which wasn't available before and also mixed debris beds of Calcium-Silicate and fiber and Calcium-Silicate and RMI.

DR. FORD: Bruce, you mentioned the correlation between BWRs and PWRs, and you've been three years doing this work for PWR steam generator breaks. How much more work would it be to do a head penetration on a PWR, if a head penetration, if a CRDM housing was ejected, and you had damage to the insulation on the top head?

DR. LETELLIER: I think it was already mentioned that that scenario would be treated as a medium-break LOCA, and it would be --

DR. FORD: Maybe I was not here at the time. Sorry.

DR. LETELLIER: Yes. Depending on the break opening, it would be very much the same, perfectly analogous as far as debris generation and transport.

DR. FORD: And the data to support that?

DR. LETELLIER: Would be the blowdown calculations from a code like RELAP, thermal-hydraulics, in comparison to debris-generation data that were produced.

DR. FORD: Okay.

CHAIRMAN WALLIS: From the point of view of cost-effective regulation, we've seen that one could have made a decision some years ago not to do all this work, but simply to make a decision. This would have improved safety. Now nothing is being done while the work is being done. So there has been no effect on safety while all this has been going on.

DR. LETELLIER: I will say one thing. This is a typical level of detail that was pursued in the BWR resolution. As to the regulatory decisions, I'll defer that comment.

MR. LEHNING: Just before we go through -- this is John Lehning from NRR -- before we can pursue in a regulatory way any issue, we have to prove that it's credible and that we have a basis to go forward. That's kind of what --

CHAIRMAN WALLIS: This is integrated effects of five years of CFD, which is 170 times what you thought it was. It's a pretty big safety impact. I'm sure that's exaggerating, but if you look at the cost of not doing anything all that time, it's probably significant.

MR. LEHNING: Some of the work that we did was used to get that risk analysis and to do that parametric studying and to get those numbers. So we didn't have that at the beginning, you know, way back five years ago.

MR. DORMAN: In fact, if I remember correctly, we treated the BWRs first based on the operating experience that had been observed, and there was some judgment at that time, absent the information that's been developed here, that there was not an expectation that this was going to be a big problem for the PWRs. So that some of the information that's been developed in the GSI-191 program regarding debris generation and transport, that has brought us to where we are.

MR. ARCHITZEL: But I would come back to that reg. analysis on the USI A-43. Those costs were not unsubstantial at that time. There were benefits at that time, and they were fairly significant. The decision was made the cost/benefit didn't warrant backfit, and that's the flipper. I mean we had a cost/benefit done already. It was a good benefit and it was a very expensive fix.

CHAIRMAN WALLIS: Does the Subcommittee have other questions for this group of presenters?

MR. ROSEN: What's this last slide that's 43? What does it tell me?

DR. LETELLIER: As I said, ultimately, each component of the analysis has to be integrated together. If you look at debris generation, this figure on 43 looks at the vulnerability of a specific sump to a challenge of various combinations of fiber and particulate. This is the threshold for failure where they exceed their NPSH margin.

If you combine this failure threshold with all of the debris sources, you can generate the last figure, which shows you the range of pool -- well, of total transport that would be required to induce failure of the screen.

CHAIRMAN WALLIS: If you have no fibers at all, though, to get back to Sanjoy's point, then the product will just go through?

DR. LETELLIER: Yes, they will.

CHAIRMAN WALLIS: So then you have no fiber. Then you have infinite number of particles, and it doesn't make a difference. Some of these are low fiber volume.

DR. LETELLIER: Again, these dots on this Figure 44 do not represent particulates. They represent scenarios.

CHAIRMAN WALLIS: No, I was looking at the one before, 43.

DR. BANERJEE: It would be interesting to see what the back-up slides were.

(Laughter.)

DR. LETELLIER: You're right, of course. At the far lefthand corner --

DR. BANERJEE: It's a log scale, Graham.

CHAIRMAN WALLIS: I know we never got there, but, I mean, you get a very small amount of fiber when you get --

DR. LETELLIER: At the far lefthand corner of this figure --

CHAIRMAN WALLIS: That's ten to the zero feet cubed there? One cubic foot?

DR. LETELLIER: That's correct.

CHAIRMAN WALLIS: What's the scale here? There's a blip. Units of ten? A tenth of a cubic foot? I don't believe it.

DR. LETELLIER: This is a representation of a screen. Depending on the area and the approach velocity, there are plant configurations that could be blocked with one cubic foot of fiber and some amount of particulate. That's not a generic statement. That's very plant-specific.

CHAIRMAN WALLIS: It's true, okay.

DR. LETELLIER: Now your comment about the threshold, at the far left there is a missing line that essentially extends vertically upward.

CHAIRMAN WALLIS: It falls straight down.

DR. LETELLIER: And that represents the minimum fiber necessary to induce the thin bed effect.

MR. ROSEN: I'm having trouble seeing the exponents. On the bottom what is that, 10 squared or --

DR. LETELLIER: Ten to the zero. That's one cubic foot.

MR. ROSEN: At one cubic foot. Now go up and intersect the line. It says that -- what is that, a tenth of -- at one cubic foot of fiber you get a tenth of a cubic foot of particulate.

CHAIRMAN WALLIS: That doesn't make any sense. It doesn't make any sense. It's a pocketful. I mean it's crazy.

MR. ROSEN: Compared to the thousands or hundreds at least of cubic feet that are in the containment and are affected by these events we're discussing.

DR. LETELLIER: Again, it's not worthwhile to dissect this particular example, but --

CHAIRMAN WALLIS: Well, I think we should because we're establishing credibility.

DR. LETELLIER: It is illustrative of plant conditions with very high approach velocities and very small screen areas.

MR. DORMAN: Yes. I think when you translate an actual relatively small screen area to something on the order of an eighth of an inch of fiber bed over that area, the point here is that it takes a relatively small volume of fiber to create sufficient bed to then trap the particulate and have substantial head loss.

MR. ROSEN: The only thing I'm taking away from this chart is, if you have a very, very adverse screen configuration, sump configuration, you can plug it with a little of fiber and a little of particulate.

DR. LETELLIER: That is correct, but the point of this slide is to demonstrate that the licensees need to assess their own vulnerabilities in much the same way. They need to have an understanding of transport and head loss in order to respond to the Generic Letter.

CHAIRMAN WALLIS: This is for an existing screen and a real reactor, a real containment, this figure?

DR. LETELLIER: No.

CHAIRMAN WALLIS: No, it's not, no.

DR. LETELLIER: This is a representation of a screen that was taken from the parametric case evaluation.

CHAIRMAN WALLIS: Okay.

MR. DORMAN: But it is typical of a screen that may be found out in an operating reactor today.

CHAIRMAN WALLIS: It is?

DR. LETELLIER: This is a particular case study from the parametric report.

DR. BANERJEE: How many square feet -- because the volumes don't tell me anything unless I know how big the screen was here. How big was it?

DR. LETELLIER: I don't recall.

DR. BANERJEE: I mean, if you have a screen this big, of course, one-foot square is a lot.

DR. LETELLIER: There are some cases of very small screen areas like 10 to 12 square feet.

DR. BANERJEE: I see. Okay.

CHAIRMAN WALLIS: Okay, anything else?

DR. LETELLIER: Thank you for your interest and your time.

CHAIRMAN WALLIS: We would like to thank you all for very interesting presentations.

Would the Committee be willing to continue now, just keep going? I'm sorry to keep you waiting.

MR. BUTLER: No problem.

MR. ROSEN: I think that was a good presentation. It was very useful. Thank you.

MR. BUTLER: May I use this overhead projector?

Shall we proceed?

CHAIRMAN WALLIS: Yes, please.

MR. BUTLER: First off, my name is John Butler. I'm a Project Manager at the Nuclear Energy Institute in Washington.

What I would like to do is give you a little bit of an overview of what the industry activities are in this for GSI-191.

One of the points I want to make from the start is that we have been active observers in the NRC activities in this area, enough to become convinced ourselves that this is really an issue that we need to take on. So we are actively pursuing addressing the issue at PWR plants, independent of the NRC activities to issue a Reg. Guide or a Generic Letter.

Our activities, our schedules have been developed independent of that. The schedules that the staff has pursued in developing and issuing that guidance has the potential to impact our already-stated schedule, but that is something we'll just have to evaluate as things progress. But I did want to make the point that we are taking this issue seriously.

CHAIRMAN WALLIS: So you're taking the lead? It must mean that Los Alamos is behind?

MR. BUTLER: Consider it a baton pass-off. Research had the lead, ran with it, and has passed the baton to us. The end result is we have to finish the race, and I think at some point NRC is going to stop and turn it over to us.

What I'm going to try to cover in a very --

MR. ROSEN: I don't think so. I think the utilities have to finish the race.

MR. BUTLER: I'm speaking for them.

MR. ROSEN: But they have to do something in the plants.

MR. BUTLER: Yes.

What I would like to do is address, in a general fashion and fairly quickly, who is involved in this activity, what activities we currently have underway and what we're trying to accomplish, and when we expect to have that completed.

First off, who is involved?

CHAIRMAN WALLIS: The usual suspects.

(Laughter.)

MR. BUTLER: Well, the important thing to point out here is that it's not just NEI, a typical

NEI task force where we go off and grab some people and we sit around and talk. We've actively involved all three of the PWR owners' groups. They have their own resources. In fact, it's the owners' groups that are actively funding the development activity for this.

We also, as almost in an advisory capacity, have a Task Force that has involvement of, again, PWR utility representatives, EPRI. We also have, at their request, allowed EDF to join our activities.

You touched on it briefly in the prior discussions, what the international activities are. The French are actively involved, and they are very actively trying to see what the U.S. is going to do. It's not clear to me right now who is going to take the lead in this resolution, but, again, our activities have to run independent of what the international community is doing. We have to proceed to close this issue out.

But we are very interested in following what the French and other European nations or other international representatives are doing to address this issue. So we're trying to stay connected with that. Having somebody from EDF on the Task Force helps us there.

We have a number of consultants who have expertise in various areas actively participating on the Task Force, and we're thankful for that because their participation is done gratis. We're lucky to have them participate.

What I have tried to do here is kind of outline that there's three general areas of activity that are currently underway. The first area there is really trying to get our hands around all the data that has been collected, all the research we've conducted, some of it contradictory to prior research. So it's a lot of information, a lot of research, a lot of data.

CHAIRMAN WALLIS: So you call NUREGs data, too? I mean, they're information.

MR. BUTLER: Information, yes. I mean a lot of the NRC-funded activity and test data is documented as part of NUREGs.

A lot of research that has been done is not directly applicable to the conditions of PWR, so there's clearly an effort in evaluating that data to make sure that it's directly applicable or the range of applicability to PWRs, and where it's not, what of that information can be used. So there is a significant effort just taking the data that's available and assessing how we can best use that data.

Beyond the test data, there's also a need to better understand PWR plants. You're already familiar somewhat with the guidance we issued this past spring for plants to go out, as part of our analysis, to assess what the debris sources are, to just get a better understanding of their containments.

A lot of the information, a lot of our understanding was based simply on their design drawings, and this provided an opportunity or the impetus to go into their containments and either confirm that their understanding of their plant was correct or, where it wasn't, to correct it.

So knowing what the plants have in their containments is needed in order to, once we have the evaluation methodology, to then jump-start the final step, which is to implement the resolution on a plant-specific basis.

The main task, as you might expect, is developing the methodology itself. I guess I'm getting ahead of myself.

CHAIRMAN WALLIS: What do you see for a methodology? Do you see sort of a general computer program where you fill in bits that are characteristic of your particular plant and then the machine runs and out comes some number at the end which says you're okay or you're not?

MR. BUTLER: No, that would be a possibility if there were more similarity among all the PWRs, but the condition that we have is there is a very wide variability of the PWRs.

CHAIRMAN WALLIS: That's what concerned me from the start, when we looked at this the last time, is that every utility is going to have a different situation. You can see all the amount of work that Los Alamos has been doing, and you can't do all that for every plant.

MR. BUTLER: No, and what I anticipate, with the guidance of the methodology, would be primarily is a framework. I'll use a number of words here. A framework, you'll have to address the problem in pieces: a regeneration piece, a transport piece, an accumulation piece, the same pieces that are addressed in the Reg. Guide.

You'll have a number of tools that you can use to assess each of those pieces. How you use those tools depend upon your particular situation.

There will be options to take a conservative approach with its incumbent impact on the final analysis or to put more resources into a higher-fidelity approach. So the guidance will provide guidance or options on how you can resolve those individual pieces with some information on what the potential impacts of each approach would be, so that plants could make an informed decision on which was the best approach.

We all know that there's always a quick approach, and I wouldn't call it a "dirty approach," but a very expensive approach just to assume that all the debris is generated; it's all transported to the sump, and install the largest sump you can get away with. I'm not even sure that all plants could get away with that, even if they had unlimited resources, because of just the configuration of their lower containment may not allow as large a sump as they would need under that assumption.

Free area may be large, but contiguous free area in that lower containment is not necessarily a large value.

DR. KRESS: What do you think of this sphere of influence to get the amount of debris in the first place?

MR. BUTLER: Pardon me?

DR. KRESS: This sphere of influence based on the pressure, stagnation pressure, do you think that's sort of the direction you'll take in the NEI?

MR. BUTLER: I imagine so, yes. I mean, as you discussed, there are pros and cons to that approach. The hope is that it can be demonstrated to be conservative.

We already know that in a lot of cases it will not impact the final result because it takes very little debris and very little fiber material and very little particulates to make a difference. So whether or not you assume a large value or half that large value, you still --

DR. KRESS: You've still got to deal with it.

MR. ROSEN: Yes, precisely. So I've already made that recognition, which I believe you just said you have. Is the industry thinking about replacing some of these fiber and particulate insulations with RMI?

MR. BUTLER: We have not advocated that. We have not put that forward as a position that a plant should take, but I think you're correct in that some plants have been making corrective changes in their insulation.

MR. ROSEN: Because there's two ways to go with this problem. One is to build a big sump to take more junk. But if you have already determined you can't build a big enough sump, given all of the stuff you have up in the containment, the next way to do it is to remove some of that and use some other kinds of insulation.

CHAIRMAN WALLIS: It's about the only thing you can do. And if you can't make a bigger sump and you know that the present stuff is going to get there, 50 percent or 70 -- it doesn't make any difference; you've got much more than enough to clog the sump no matter how big you make it, then go do something else.

DR. BANERJEE: How did the BWRs do it? Because they made pretty conservative assumptions, and they seemed to have solved, at least from what we heard --

MR. BUTLER: The BWRs, No. 1, they benefitted from the fact that there is a high degree of similarity of all the BWRs, or at least they are broken down into two generally highly similar types. So they could work on a single solution that could be applied generally by everyone.

In the end, I think it is fair to characterize their solution to be install the largest, most effective strainer that you can get away with, and that allows you some freedom to accept some highly-conservative assumptions and to not be forced to investigate some areas of high uncertainty.

DR. BANERJEE: But what we heard -- now I don't know the details -- was they didn't just install large strainers; they installed clever strainers.

MR. BUTLER: Highly effective.

DR. BANERJEE: Right.

MR. BUTLER: That's what I mean by effective, yes.

DR. BANERJEE: Yes. So that, in fact, you didn't have to put very large strainers, but you did it in a clever way because it had this power of the slow paths and you had the velocity normal instead of tangential, or whatever, going through; I don't know.

But, anyway, the upshot of all this was that they solved the problem in a very effective way, from what I heard. Now is it that you cannot accommodate that amount of strainer in a PWR?

MR. BUTLER: I imagine some plants can. I mean, again, I made the point that the BWRs benefitted from the fact there's a high degree of similarity --

DR. BANERJEE: Right.

MR. BUTLER: -- among all their designs.

What we have to recognize in developing our methodology is some plants will be able to accommodate that as a solution; other plants will find that much more difficult. So we want our guidance to provide enough flexibility or enough options to utilities in how they address the problem.

Some may address it in a design fashion by installing an effective, large sump. Others may address it by trying to reduce their debris generation source, you know, changing their insulation type. Others may try to do it through analysis and showing that they don't transport material to the sump.

CHAIRMAN WALLIS: I think there would be a lot of pressure to do that, and a licensee finds a real box and doesn't have a big sump confidence, strainers at work, if he makes the extreme assumptions, you know, he's going to say, "Let's find some consultant who is going to cut back on all these conservative assumptions and prove that it isn't really so bad."

DR. BANERJEE: Was NEI involved with the BWR solution?

MR. BUTLER: No. That was done under the guidance of the BWR owners' group.

DR. BANERJEE: Because they have many different generations of containment. Each one is completely different from the other.

MR. BUTLER: The degree of differences among the various generations is not as significant --

DR. BANERJEE: I see.

MR. BUTLER: -- as the differences that you would see in PWR containments in terms of the insulation types that are used, the configurations, the volumes, the sump types that are used. There's a very high degree of variability among PWRs.

Well, I think I've addressed a number of these slides.

CHAIRMAN WALLIS: Well, it seems to me it's not just getting all this data. Someone's got to do some really creative engineering analysis to figure out how they make the right predictions. Los Alamos has been working at that for some time. Are you guys going to mount a similar effort?

MR. ROSEN: Not before September 2003.

CHAIRMAN WALLIS: I doubt it, yes, no way. So I was just wondering, has this begun to be a rather superficial thing by September 2003 in terms of technical analysis? I mean, it may point the way to what's out there, but in terms of your own analysis, I don't think you have time to do it.

MR. BUTLER: Well, the guidance methodology is not going to include the CFD analysis that someone would need to calculate transport fractions. That would be part of the implementation because you need plant-specific data. It's a plant-specific resolution item to perform those calculations.

Our methodology would only go to the point of identifying what you would need to look at to address as part of that CFD analysis, guidance on what transport fractions for different materials makes sense, the inputs to that analysis, like the actual plant model needed to calculate results for a particular plant are a plant-specific resolution item and would follow issuance of our methodology.

MR. ROSEN: Let me ask a question of the staff. How long is it, in your -- and maybe it's in the Generic Letter and I haven't understood it -- how long is it before you expect the plants to make either appropriate fixes or be able to show that they're okay with what they have?

DR. WEERAKKODY: As I recall, we don't specify an exact date, but we have specified certain timelines for initial assessments and then evaluations, and then getting enough information.

The reason we don't necessarily like to do that is, as some of you had sometimes thought, the particular plant does the initial assessment and then concludes that they want to jump in and do a fix. They can do that, like Davis-Besse did.

But there may be another plant that determines that they have enough -- that their plant is not susceptible based on the initial assessment, and then it will take them, I think, to collect the data, some of the data they need from the containment, they might do that during an outage. So it might be a couple of years. So the time that it would take to take this issue to a total completion could be very plant-specific.

MR. ROSEN: You have a large tolerance for delay. My fuse is somewhat shorter than yours.

DR. KRESS: Especially with 170 CFD increase.

MR. ROSEN: Yes.

DR. WEERAKKODY: Is that 170 percent or 170 times?

MR. ROSEN: A hundred and seventy times.

DR. WEERAKKODY: Yes, the 170 times core damage frequency, that is a conservative number. If you really thought the core damage frequency of the plant's 170 times higher, this would be an issue that would require something like an audit.

We take that PRA number as an upper bound and take the issue very seriously. Now in terms of the timeframe, we don't have a large tolerance. What I'm trying to get across is each plant, when they get the Generic Letter, they will be required to do an initial assessment. As a result of that initial assessment, it will be their responsibility to conclude whether they are susceptible or not.

If they conclude that they are susceptible with relative certainty, then we would expect them to take relatively quick action because --

MR. ROSEN: So what's relatively quick? I mean, it seems to me if it's not -- it sounds like I didn't miss it in the Generic Issue; it's not in there.

Is there a date that the staff has in mind for when they want to have all the PWRs with this problem behind them?

DR. WEERAKKODY: The furthest date we can anticipate I can't recall off my mind. Even if a plant decides that they are not vulnerable, I think it can then go up to like 2007, but that sort of plan, you know, they have done the evaluation and have concluded that they are not susceptible.

MR. ROSEN: Well, if they're not susceptible, they don't have a problem today. So, I mean, I'm just saying there's two ways to get a way through this problem. One is to prove that you're not susceptible, and I think there will be some plants that can do that. Plants, for example, with very large containments with lots of reflective metal insulation and very little of the other kind, and very big sumps, will probably be able to show that they're okay.

Then there will be plants that couldn't show it no matter what, and they'll have to make a fix, either take out some of the other insulation they have and put in some reflective metal insulation or put in bigger sumps, or both. Those plants will have -- it will take some time, clearly, to do that.

I don't think they'll be able to do that in one outage unless they shut down and stay down for a long time. They'll have to get to work on it. Every bit of that kind of insulation that's not good that they take out during an outage is a good thing, and replace with the reflective metal insulation.

So it seems to me you need to get on with it for the plants that do have a problem. The idea of not having a drop-dead date to me is puzzling.

CHAIRMAN WALLIS: It gets back to this whole Generic Letter being too polite in sort of saying, "Take a look at it and let us know, and then maybe we'll figure out what to do."

MR. ROSEN: If you say you have a problem, it seems like the regulator ought to say, "Okay, we understand it's a probablistic, stochastic process, and it's probable you won't this have problem during `X' amount of number of years," but we need to say that we're going to limit our liability and our vulnerability by saying everyone won't have this problem by "X" date and having picked that on some basis.

DR. WEERAKKODY: I think if you go to the pages where we discuss specific requests for information or action, we do specify specific due date for each of those. I can't remember the exact date for each of them, but we say, when you receive this letter, you know, by a certain date do this.

MR. ROSEN: Well, I'll study it some more.

CHAIRMAN WALLIS: Well, there's a 90-day response time.

MR. LEITCH: We're at the stage where

we're sort of a plan for a plan rather than actual physical changes.

DR. WEERAKKODY: The Generic Letter does take you through several steps. In fact, what we have done is, if you go to the Generic Letter, page 9, in Item 1 we say, within 90 days of the date of the Generic Letter the licensees are expected to provide certain information.

Then if you go to Item 2, we say, within 90 days of the date of completion of the requested evaluation of the susceptibility that the ECCS basically can function, the plants are required to provide us information.

CHAIRMAN WALLIS: I think they're going to be in a real bind to do it in these two 90-day periods.

MR. ROSEN: But even so, if they could do it, then that's 180 days, and then you get to 2(b), as in "bravo." It says, "if any plant modifications are identified as being necessary to assure compliance with regulations, that other regulatory requirements will not be implemented until a future scheduled outage described in the interim compensatory measures."

DR. WEERAKKODY: Okay.

MR. ROSEN: It sounds to me like you might put them all in during the next outage. Is that the implication?

DR. WEERAKKODY: No, I think what we are doing here is, you know, there may be plants out there, when they look at this information, they might be looking at information and the analysis they need to do within the first 90 days, and conclude that their ECCS is degraded but operable, and within the regulation that takes them to the instructions that we give them under Generic Letter 91-18. So they would be required to take interim compensatory measures while they are taking care of the issue.

MR. ROSEN: They absolutely should do that now. But it seems that 2 "bravo" or the next one, 2(c), ought to say something like, "All required modifications should be complete by" -- and you pick a date and say, "or provide justification for not meeting that date."

MR. LEHNING: Kind of the problem with that is, like when you request an action, you have to have a regulatory basis for doing that, a cost/benefit, but at the time we're asking someone to do that, but say if a licensee is just barely out of compliance, they have just this one piece of insulation, and if they have just one break, it's a real low probability. So we can't tell them, you know, we don't have a basis to say, "You need to do it right away." If a plant has a really bad configuration --

MR. ROSEN: I didn't say right away. I said pick a date.

MR. LEHNING: Or even to pick a date, we can't say you have --

MR. ROSEN: I didn't say right away. Don't overreact. What I said is, pick a date, a date certain, which we then could say, okay, now we can calculate the vulnerability of the fleet, assuming everybody waited that long. Otherwise, it's not bounded.

CHAIRMAN WALLIS: Let's see, this draft has not been given to NEI, this Draft Generic Letter? So they don't know what we're talking about?

DR. WEERAKKODY: Dr. Rosen, what we can do is we will think about your comment and some of the reasons --

CHAIRMAN WALLIS: I think what is going to happen is, if you extend this out even without the tightness that my colleague wants you to add to it, that it may well be that the industry is going to come back and say, "We can't do it." They'll scream, you know, this is an unreasonable thing.

They'll have comments on the letter, and then you'll have to fight them, if you believe what Los Alamos has been telling us about this being a real problem with all this debris, and it only takes a bucketful of fibers to plug a screen, and so on.

MR. ROSEN: Well, I'm not arguing for precipitous action. What I'm arguing for is definitive -- a definitive timeframe, a definitive framework that everyone knows about.

CHAIRMAN WALLIS: Well, I don't think that your NEI guidance is going to be available in time, it's going to be deep enough technically to satisfy the NRC the way that they're going. So this Generic Letter is going to go out, and then the licensees are going to be asked to do something, and they won't know how to do it. The only thing they can do is adopt the Los Alamos approach.

MR. ROSEN: But, Mr. Chairman, we have got to decide what we're going to say to the full Committee.

CHAIRMAN WALLIS: And it's going to be interesting.

MR. ROSEN: And maybe we should allow Mr.

Butler --

CHAIRMAN WALLIS: Yes, I think we should let Mr. Butler -- we're sort of talking among ourselves. Maybe we should let you finish your presentation, and then we will decide.

I thought you would come up here more sort of saying how the industry will respond to the kind of thing that they're going to be asked to do, and whether or not they can manage to do it.

MR. BUTLER: We'd be glad to do that after we have seen it.

CHAIRMAN WALLIS: See, you can't do that until you've seen it, right?

MR. ROSEN: And I'm complaining about what I see as not being definitive enough.

MR. ARCHITZEL: I think I would like to make a comment that, you know, this is really still considered an industry initiative, and we're responding to that initiative.

CHAIRMAN WALLIS: Well, it's an industry --

MR. ARCHITZEL: That's the premise behind that Generic Letter. There is an industry initiative that we presume is going to be acceptable. If that premise isn't good, it's still industry's action and it's their responsibility to --

CHAIRMAN WALLIS: Yes, but your Reg. Guide is very specific about what it wants done.

MR. ROSEN: Well, it may be an industry initiative, but it is a regulatory matter, and it isn't up to the industry what the staff of the Commission does. Industry's participation and cooperation has been good. That's wonderful. But at some point I'm arguing that -- and I'm speaking to the staff and to my colleagues -- that this has gone on long enough without a date certain.

CHAIRMAN WALLIS: Well, there are two 90-day stages here, which even then they're going to put a lot of pressure on industry.

MR. ROSEN: For analysis, yes. Collecting data and analysis, but --

CHAIRMAN WALLIS: And having a plan of what they're going to do.

MR. ROSEN: And then all I'm asking for is them doing it. You know, if you put a date certain on the end of it, all the other things have to start backing up, and pretty soon you're able to decide whether you can use those other dates in any reasonable way. It may be just what you say, but if you put a date certain on it --

CHAIRMAN WALLIS: Well, NEI must be pretty close to the pulse of industry. I mean, they've got a letter saying they've got to come up with -- 90 days/90 days, that's not very long. It's half a year. By that time, they're going to know what they're going to do to fix the problem? Do you think that's a realistic thing to ask industry to do?

MR. BUTLER: If you're asking me what would be the best time to issue the Generic Letter and start that 90-day clock, it would be when we have the methodology and have agreement with the staff on that methodology.

CHAIRMAN WALLIS: Well, I don't see -- you've shown us no methodology. So I don't have any faith in you having it in half a year either.

MR. LEHNING: Mr. Chairman, may I make a comment? I think there's just some misunderstanding about the two 90-day periods. The first 90 days is the 90 days after the receipt of the letter, and then the second 90 days would be --

CHAIRMAN WALLIS: Yes, but you're not going to send the letter out, you see. You're going to wait and wait and wait and wait.

MR. LEHNING: It would be 90 days after the licensee completed the evaluation, not 90 days after the first submittal --

CHAIRMAN WALLIS: So when is this letter going to go out realistically?

MR. LEHNING: The schedule? I think it's planned for the summer.

CHAIRMAN WALLIS: So it's pretty soon?

MR. LEHNING: For the final, for the final version of the Generic Letter. The draft is planned I think in March or April, yes, for the draft, for public comment.

MR. DORMAN: The clarification that needs to be made here is that the first 90-day period is measured from the issuance of the Generic Letter. At that time the licensee provides a plan, and that plan includes when they propose to complete their analysis. Then the staff has an opportunity to determine whether that timeframe is appropriate and acceptable.

CHAIRMAN WALLIS: But if they don't have the NEI guidance or analysis, how are they going to plan to complete their analysis?

MR. DORMAN: That would, obviously, impact them. But the second 90 days, then, doesn't start from their first response. The second 90 days start from completion of the analysis in accordance with whatever plan they presented after 90 days. So the second 90-day report is not 180 days after the Generic Letter. It's probably something longer than that.

CHAIRMAN WALLIS: I just thought, my intuition is it will take NEI years. You're asking for days. It isn't compatible. Maybe I'm wrong. Maybe you guys are really ready to issue a guidance and everything's worked out.

MR. BUTLER: My concern really comes at it from a different point of view. I mean, I agree that there is uncertainty with the September date. I mean you just have to accept that with any kind of effort that addresses this many issues, as many issues as this one does.

But my concern would come from a postulated schedule where a Generic Letter comes out in final form, starts a 90-day clock. Every PWR utility then looks at it and says, "I've got to have this methodology right now to begin my evaluation." That then puts a high degree of pressure to complete that very quickly and get it out to industry, and during a time when discussions are probably at a critical stage with NRC staff, you're trying to complete everything.

We would basically be forced to try to complete the methodology with too many cooks in the kitchen, and that will cause some problems in itself. That's one of my main concerns.

CHAIRMAN WALLIS: Well, I'm concerned about your having any cook. I think you're going to have a Task Force which is thinking about it and talking about it, and you don't have any cooks cooking in the kitchen at all.

A cook is going to actually produce this guidance. You know, here's some analytical method; it's based on fundamentals and data and engineering, and so on and so on, and here's the justification for it.

MR. BUTLER: Oh, we do have --

CHAIRMAN WALLIS: Do you have all that stuff?

MR. BUTLER: The primary contractor on the methodology is Westinghouse.

CHAIRMAN WALLIS: And they have this methodology there? They just have to unveil it?

MR. BUTLER: We are working on it. I mean, we are working on it. We've got a fair, a high degree of completion on the regeneration portion of it, looked at drafts of other portions, of debris transport and the different phases.

CHAIRMAN WALLIS: So if we advise the

staff to go ahead, send this out, and as fast as they can implement it, you guys can respond?

MR. BUTLER: As far as issuing it for draft, a draft for comment, once it's issued for a draft to comment, one of the comments we'll provide is on the schedule and some of the concerns of how that schedule can impact or interplay with the guidance development, some of the same concerns you've expressed.

CHAIRMAN WALLIS: Well, without seeing anything from Westinghouse, there's no way I can assess this guidance that you have as a hope.

DR. WEERAKKODY: I do want to make one comment. Hopefully, at least partly, this is Dr. Rosen's question or concern.

One of the things we have, or we are trying to accomplish with the Generic Letter, is within the 90 days, before the licensees do a full-blown evaluation, ask them to either put interim, compensatory measures in place that could reduce this aspect of it significantly.

In fact, the Generic Letter, we do identify some of the known interim, compensatory measures for this activity in the Generic Letter itself.

MR. ROSEN: I understand you're going to ask them for interim, compensatory measures. My problem with them is that, while I am sure the utilities can do that and define them and write procedures, operating procedures, and train operating crews to, in fact, implement those interim, compensatory measures, given the phenomenology we've heard about today, I'm not sure that they'll work. I'm not sure they'll be effective, interim, compensatory measures.

CHAIRMAN WALLIS: Well, I think this is very interesting. I think we're setting a stage for quite a drama.

(Laughter.)

MR. ROSEN: We're talking about a low-probability event.

CHAIRMAN WALLIS: Yes, maybe it will go away.

MR. ROSEN: But, still, we have to assess, under this very stressful phenomenology, that operators take these extraordinary interim, compensatory measures, including shutting off recirculation, or whatever those measures are, things that are counterintuitive to them.

But even if they did them, would that let

-- I presume that's to let all the particulates and filterable materials settle out, and then they can start it up again. But would that really de-suspend them or not? I'm not sure that I've been shown data that shows that that would be effective.

DR. KRESS: I thought the pool CFD velocity possibly showed that they would settle out in the sump, but they would make it to the filter anyway, even if you cut them off and them wipe them and suspend, and turn it back on. So I don't think that's a compensatory measure that would be acceptable.

DR. BANERJEE: How many plants are at sort of risk compared to -- and cannot apply a filter solution like the BWR solution? Because that, we know the area of the filters. So how many plants have low areas or how many plants are at risk? If we can do this assessment fairly rapidly -- the Los Alamos people probably already did it. How many are we talking about?

DR. WEERAKKODY: I know some of the information that was published in the Los Alamos report. I think we may be mixing up the risk aspect of this analysis, the concept of the risk analysis, with the establishment of the credible concern here.

What the Los Alamos study showed was that this is a credible concern, and in the process they did the risk assessment with some considered assumptions and showed that the core damage frequency could go up by a very significant factor.

I think the part where Los Alamos concluded that this is a credible concern is mainly based on deterministic. In other words, we did not factor in the probability of the breaks. We did not factor in the probability of different events happening or not. We just concluded that, based on all the information, this can happen.

DR. BANERJEE: Yes, but it's not a very huge thing. We are talking of plants which have insulation with particulate matter in it because we were told fiber is always there, and then it's filter area per megawatt after that, more or less.

If that can give you then which plants, you can change the filter to a BWR-type filter and which ones have to do something different. Right? I mean it's not a huge problem. I mean it may be a huge problem for the plants that cannot do it, but there must be just a handful of these.

CHAIRMAN WALLIS: I think we'll get this perspective. If these things go out, this perspective will have to be developed, won't it?

DR. BANERJEE: Right. So you're saying let it happen?

CHAIRMAN WALLIS: Well, we have Mr. Butler here still, and we've got ourselves talking among ourselves. But do you have any wisdom for us on these matters?

MR. BUTLER: Just key points to not forget: There is no single answer to this. Because of the high degree of variability of all the PWRs, there are, in effect, 63 different answers to the problem. There is a whole range of sizes and PWR sumps, and you could probably identify 10 plants that have the smaller sumps, but those also may be the 10 plants that have a low probability of debris transport or a high degree of RMI.

You know, there aren't plants that stand out because of the worst circumstances in all relevant aspects; there is just a high degree of variability. Because of that, we need to provide the plants with the tools and the options and the time for them to address it in the most appropriate fashion for their plants.

CHAIRMAN WALLIS: Well, I was sitting here listening to Los Alamos. I don't see, from what they presented, which was very interesting and had an awful lot of things, I don't see a clear path which says, knowing what they have told me, I can see the way to developing guidance for a plant. Maybe you guys are much smarter.

Knowing all the stuff they presented today, if you're going to consider all that stuff, I can't see my way through the thicket to say, "This is the way I would develop a guidance for a plant." I would probably have to fall back on something conservative.

MR. BUTLER: And in some areas we will likely have to do that.

CHAIRMAN WALLIS: And it might be very conservative.

MR. BUTLER: Well, we're trying to address some of the major conservatisms as part of our guidance upfront in discussions with staff. You are already aware of some of those discussions in the LBB area. We think the current GDC-4 regulation allows us to exclude the regeneration for LBB-qualified --

CHAIRMAN WALLIS: Do you want an opinion of this Committee on the LBB issue? It hasn't been brought up today.

MR. BUTLER: I wasn't going to bring it up in my discussion. I'm not sure I want to ask the question if I'm not willing to live with the answer, but I'll leave it to you to express your opinion or not.

MR. ROSEN: Well, I would like to come back to this date thing. I think I've read this more carefully, and I think it actually is in there, but I want to verify that with you and the staff, not you, John, because you haven't got it in front of you.

But the staff says there are two 90-day periods, and the second 90-day period, it says, "Within 90 days of the date of completion of the requested evaluation of the susceptibility, provide the following: a description of the actions taken," et cetera, et cetera.

Then it goes on to "a general description of an expected implementation schedule for any plant modifications that are necessary to ensure the availability of the ECCS and CSS recirculation functions under the postulated debris loadings. If required modifications will not have been completed by the end of the subsequent refueling outage, provide justification."

So that, very simply to me, adds two 90-day periods -- that's a half a year, 180 days, half a year -- plus a typical refueling outage schedule or refueling cycle, like another 18 months.

MR. LEITCH: The two 90-day periods are not back to back necessarily.

MR. ROSEN: They're not back to back. Even if they were --

MR. LEITCH: The second 90-day clock can start a year after the end of the first one.

MR. ROSEN: But even if they were -- let's just say that's the minimum --

MR. LEITCH: Yes, right.

MR. ROSEN: The minimum would be a half a year plus a year and a half. So that's two years. That's the minimum but not the maximum. So I think my question stands.

MR. LEITCH: Yes.

CHAIRMAN WALLIS: Why are they not back to back?

MR. DORMAN: Because the first one requests a schedule --

CHAIRMAN WALLIS: Yes.

MR. DORMAN: -- for their evaluation, and then they do the evaluation. When they complete the evaluation, the second 90-day clock starts.

MR. LEITCH: They haven't prescribed the time to do the evaluation.

MR. DORMAN: So it allows for the licensee to propose a time period for the evaluation. Obviously, if they came in with five years -- maybe that's a hard part over that.

CHAIRMAN WALLIS: Okay. So you've got April 1st, 2004. It can also be within 90 days of the completion of the containment surveillance, or am I --

MR. ROSEN: Whichever is later.

CHAIRMAN WALLIS: Yes, whichever is later. Well, okay.

So what happens? These things go out for public comment? Is that the way it goes?

DR. WEERAKKODY: Yes.

CHAIRMAN WALLIS: Now how long does that take? Sixty days? Then by then you get the comments, and then you make a decision in how long?

MR. LEHNING: The final issuance?

CHAIRMAN WALLIS: Yes.

MR. LEHNING: Is that what you're asking, what the final issuance? It is planned for, I think, the fall.

MR. ARCHITZEL: I've got a schedule here. Particular dates, we've got it laid out.

So the question is, when does the final Generic Letter go out?

CHAIRMAN WALLIS: Yes.

MR. ARCHITZEL: Okay, the final, it's currently scheduled for August.

MR. DORMAN: Yes, and for the regulatory guidance, it's scheduled for September.

CHAIRMAN WALLIS: Yes, okay.

MR. ARCHITZEL: But, remember, this hasn't been through the CRGR yet, and so the process could slip.

MR. ROSEN: You may be asking too hard a question for the ACRS. The ACRS is trying to figure out how you're managing this, and we don't --

CHAIRMAN WALLIS: That's right. I think there's so many imponderables about whether CRGR is going to approve it or how much slack you get from industry, and all that, that I think the only thing that we can really do at this stage is to go into a sort of caucus now and say, "Go ahead, issue these things for public comment."

MR. ROSEN: Well, we can do that for sure.

CHAIRMAN WALLIS: It's too early for us to get involved in the melee here.

MR. ROSEN: Right, but we can certainly express our angst about not having a schedule with an end date, if that's the will of the Subcommittee and the full Committee.

CHAIRMAN WALLIS: I guess we could write a Larkinsgram, and then we could put in a sentence or two about needing an end date or something.

See, if we want the Committee to write a letter, then we're going to have to ask these folks to come before the Committee in two days, and we're going to have to schedule it and squeeze it into a schedule which is already full.

MR. ROSEN: Well, aren't they supposed to? It's already scheduled?

CHAIRMAN WALLIS: But it's a short thing. It's only 15 minutes or something.

MR. SNODDERLY: No, no, no. Right now there's an hour and a half scheduled.

CHAIRMAN WALLIS: Oh, it's an hour and a half scheduled?

MR. SNODDERLY: Excuse me. This is Mike Snodderly.

Right now there is an hour and a half scheduled from 10:30 to 12:00 on Thursday.

CHAIRMAN WALLIS: But if it were a Larkinsgram, it would simply be a discussion with this Committee, maybe half an hour with the full Committee, saying that there are things that we have learned today and we just will share it with our colleagues, but it wouldn't be that this would go into a letter where they would they have to make their own decisions.

MR. ROSEN: But, typically, Larkinsgrams were used to go out and to say, you know, it's okay to release it for public comment. But I have a more substantive concern, which is that this is, I think, an important problem potentially in some plants, and that there seems to be no clear resolution date at least proposed in the Generic Letter.

DR. KRESS: I share that concern, and that would take a Committee letter?

MR. ROSEN: Right.

CHAIRMAN WALLIS: It would take a Committee letter? You can't put that in a Larkinsgram because the whole Committee has to --

DR. KRESS: We normally don't put that substantial of comment --

CHAIRMAN WALLIS: All right, so the whole Committee would have to confront the issues, and they would have to have a presentation?

DR. KRESS: I think so.

CHAIRMAN WALLIS: And they would have to come up-to-speed. So they would have to have a shorter version of what we heard today.

DR. KRESS: Now be aware that any members that aren't here, at least two of them that sit over here are well up on this issue and went through the BWR part of it, and are quite aware of the problems and the ramifications. So it's not like they need extensive educating.

CHAIRMAN WALLIS: Well, I think the staff already knows this Subcommittee is concerned about this business of dates, and so on. Do we need to have the authority of the whole Committee invoked?

MR. SNODDERLY: Graham, if I can make a suggestion, I would like to say that this could be discussed at the P&P tomorrow, and in the meantime we ask the staff to prepare a presentation for the full Committee and we would get back to them before Thursday.

But, as of right now, we would prepare, have them condense their presentation for an hour and a half on Thursday from 10:30 to 12:00, with emphasis on the schedule of the Generic Letter, what is requested, and when they think that would be anticipated.

MR. ROSEN: When they think that would lead to fixes in the plants that need it?

MR. SNODDERLY: Right, and whether there would be a final date or not, and also to reflect, I guess, on page 7, because it seems to be very contingent upon NEI developing this subsequent guidance by September 2003. Because when you send in your 90-day letter to say what kind of an evaluation, you might say, well, I'm going to do it in accordance with the methodology being developed by NEI. So if that goes beyond --

MR. ROSEN: Almost certainly every plant will do that.

MR. SNODDERLY: Right, right. So that seems to be a key.

CHAIRMAN WALLIS: Well, I have very little in there being a methodology.

MR. SNODDERLY: Right. So that would go with your concern and Dr. Kress' that this does appear, and Dr. Rosen, that there isn't this end-all date or a closeout date.

And then you could decide at the P&P whether you want to discuss that --

CHAIRMAN WALLIS: That's why I think that before we go to the P&P, I think this Subcommittee has to decide what they want and tell the P&P that's what they advise them to do.

MR. ROSEN: But two members of the P&P are here.

CHAIRMAN WALLIS: But, you see, my inclination was to say there's enough here; it's going to stir up enough stuff that you could send out a rough direct letter and the Reg. Guide, and there may be a few details like discussed here to be fixed up, but that can be fixed up when the public comments come back. Send this out, and that's going to start the ball rolling.

It's going to put NEI on the spot. It's going to put some of the licensees on the spot, and it's going to put LANL on the spot to be more specific about what they're recommending to the staff. Then things will happen.

MR. ROSEN: Well, I think what we're talking about is a procedural question, which I think maybe we could get some help from the staff.

CHAIRMAN WALLIS: What I was hoping --

MR. ROSEN: Can we put that put that much into the Larkinsgram?

CHAIRMAN WALLIS: Well, what I was thinking, that we simply have a Larkinsgram saying we have no objection to these going out for public comment. They will then go out for public comment.

That's all we need to say. Everything else will take its course. It has to. It just follows on from --

MR. ROSEN: Not if we don't say something about the schedule.

CHAIRMAN WALLIS: We'll see it again. It comes back from --

MR. ROSEN: No, no, I'm saying, not unless we put a burr under the saddle. I mean, it will continue to do what it's been doing, which is moving ahead like an iceberg.

CHAIRMAN WALLIS: I thought these 90 days were not moving ahead at a snail's pace, but maybe I'm under some illusion.

MR. LEITCH: I have no problem with recommending that we send it out for public comment in its present form. I think that it addresses one refueling outage or no later than whatever it says, one fuel cycle. I think that's a reasonable approach to send it out for public comment that way.

You know, there may be some changes in that as a result of the comments, but I think that's a reasonable approach. I am frustrated that it's taken this long to get to this point, but that's behind us now. I mean we can't recoup that time.

I mean, I think this whole issue is an

issue where striving -- what's the saying? Perfection is the enemy of good enough. I think we've killed this thing trying to analyze it. I think we've got some plants out there that we know are much more susceptible to this than other plants, and we just ought to get on with it and get those plants fixed.

But we've taken an awful lot of time with this, and we can't do anything to recoup that time at this point. There may be some lessons learned from how long this has taken, but what I'm saying is I think now the thing to do is, without further delay, get the Generic Letter out for public comments or, yes, get the thing out for public comments.

CHAIRMAN WALLIS: And the Reg. Guide.

MR. LEITCH: The Reg. Guide, yes.

DR. KRESS: Well, yes, and I agree pretty much with what you said, but I see it as somewhat analogous to the control rod drive cracking issue. Some plants are a lot more vulnerable than others. So that when the NRC went out with the Generic Letter on this issue, they gave those that were less vulnerable more time, and those that were very vulnerable, they said, hey, you had better get on with it here, and especially these, these, these.

Now I think the Generic Letter I see gives all plants equal time to assess their vulnerability and make a plan and go on. But I think that there's a missing ingredient, and that is how vulnerable are they; how urgent does it have to be when they're vulnerable, and can we give the ones that aren't vulnerable more time?

CHAIRMAN WALLIS: I don't think it helps. If they're not vulnerable, they just come back with a short answer: We're not vulnerable.

DR. KRESS: Yes, well --

CHAIRMAN WALLIS: There's no reason to get into all the topics.

DR. KRESS: I think there are gradations of not vulnerable.

CHAIRMAN WALLIS: But that's information, though. I think the NRC needs to know how vulnerable they are.

DR. KRESS: Yes.

CHAIRMAN WALLIS: They don't know it until they've got these answers.

DR. KRESS: Yes, once you find some that's very vulnerable, I think you need the answers faster and you can do something better with those. But I guess I'm coming down on the side of just going ahead and saying: Issue these Generic Letters, the drafts, and the Reg. Guide, and then let's worry about this other part when the answer is due in on vulnerable.

CHAIRMAN WALLIS: Do we need their presentation before the full Committee by the staff?

DR. KRESS: No, not if we just write that Larkinsgram.

MR. ROSEN: Well, here's what I would like to have them talk about at the full Committee: Focus on very basic phenomenology without getting into too much of it, and then get into the schedule and assure the full Committee, and me, that this will move forward, given whatever it is you say in the Draft Generic Letter.

Is that all right with the staff?

CHAIRMAN WALLIS: What do the other members of the Subcommittee have to offer for advice?

DR. FORD: Well, I agree with the issuance of the Generic Letter for public comment now, and that's the essence of the Larkinsgram. Where we're sticking is, do we put in this question of the timing?

As you know, I get very impatient when things drag on. So, inherently, I'm behind Steve on this one. Whether that needs to have a full meeting, I'm not at all sure.

MR. ROSEN: Well, it's on the schedule

already.

CHAIRMAN WALLIS: When does this come back to the ACRS? Doesn't it come back? When does it come back? Are you going to bring it back to us after the public comments and before you issue these things?

MR. ARCHITZEL: Well, the Generic Letter would not necessarily come back if there weren't significant public -- certainly, if you want it, it will come back. We were planning to come back when the guidance was evaluated by us and we were accepting it or had the significant differences in it. So that's really the next time when I thought we would come back, is when the guidance is in place.

CHAIRMAN WALLIS: You haven't really had comments on the Guide.

MR. ARCHITZEL: We don't have the guidance yet.

MR. DORMAN: We're expecting to --

CHAIRMAN WALLIS: The Guide, the Reg. Guide.

MR. DORMAN: We're expecting to come back in July to talk about the public comments on the Reg. Guide and how we expect to resolve those. That's to support the September issuance.

CHAIRMAN WALLIS: I think that that would be appropriate for us to ask at that time what happened with the Generic Letter. They sort of go together, don't they? I think you would probably want to come back with both. So we get another crack at you, and you know our concern with timeliness.

MR. DORMAN: Uh-hum.

CHAIRMAN WALLIS: We've got the majority of the Committee.

(Laughter.)

DR. KRESS: Three members missing, I think.

CHAIRMAN WALLIS: Yes.

MR. ROSEN: Five members missing, two of which know of this issue in detail.

CHAIRMAN WALLIS: I'm bothered about the ACRS writing a letter on what's after all a draft before we see the evidence. I wanted to stir up these replies from industry, so we can see what's going on, and then we can come to them with advice. At the moment it is more: Send it out, find out more about the problem, and get on with it. That's what we're asking for.

MR. ROSEN: I could live with that.

CHAIRMAN WALLIS: So we'll make a Subcommittee report? We won't ask the staff to come back to the full Committee? Or do you want the staff to come back to the full Committee?

MR. ROSEN: I think the staff should come back and talk about the Generic Draft, Generic Letter, and the schedule that it requires.

CHAIRMAN WALLIS: So then we could put it to our colleagues, would you like a Larkinsgram or --

MR. ROSEN: Or at that point we could say we suggest a Larkinsgram, but we're concerned about the schedule. We want to get on with it.

CHAIRMAN WALLIS: That's okay, too.

DR. FORD: Do I understand that the sticking point is, if it is a Larkinsgram, we cannot put in the question of scheduling, our concern about scheduling?

CHAIRMAN WALLIS: We can't add that in as a sentence?

DR. FORD: That's what I'm understanding.

DR. KRESS: I think that level of comment could probably go into a Larkinsgram.

CHAIRMAN WALLIS: Yes, why not? But then it does have to come to full Committee. If there's going to be a comment, it probably has to come before the full Committee. But I don't think we need an hour and a half. You guys can do, put the essence of it out in half an hour, and we won't go into the LANL stuff.

DR. KRESS: John's agreeing that we could do it, because it has to be voted on by the full Committee, but --

CHAIRMAN WALLIS: So we could put it in a Larkinsgram saying it will go out for public comment --

DR. KRESS: Yes.

CHAIRMAN WALLIS: -- and then say that there should be consideration about the schedule.

DR. KRESS: Yes, it's only appropriate for the full Committee to vote on it if they've heard the details of what our concern is.

CHAIRMAN WALLIS: Yes.

DR. KRESS: So we'll have to have enough for that.

MR. ROSEN: That's why I asked the staff to talk about the schedule. It's in the draft --

DR. FORD: I think Tom brought up a good analogy to the VHP situation. The degree of urgency is dependent on some sort of assessment of risk.

MR. ROSEN: Sure, and we don't know what that is.

DR. FORD: And we don't know what that is, but that, presumably, from what I'm hearing from LANL's staff coming out with, is saying that they're moving towards that assessment of risk.

CHAIRMAN WALLIS: Well, maybe it's going to be conditional, that when they get this information from the first 90 days, then they can decide if there isn't a need to move faster on the plants that have problems.

DR. FORD: Yes.

MR. ROSEN: And I think we should take the conservative position that it is likely, that it is possible that we will get some reports that say it's a problem, and that, therefore, it will then be seen to have been appropriate to have pushed to get on with it.

CHAIRMAN WALLIS: We talked about the letter. So we're asking the staff to come before the full Committee and discuss the letter, just the letter.

Do we want them to come and discuss this Reg. Draft Guide?

MR. ROSEN: I don't want them to.

CHAIRMAN WALLIS: Well, I think that it might be at least a couple of minutes because it is fairly -- I don't think you should go into details, but I think you need to point out that there is a Draft Reg. Guide, that it does ask for all the specific things. You might just have one slide that says what are those specific things. It's got to be the sources of debris and debris transport, the effect on -- they could analyze those things, and so on.

MR. DORMAN: It gives context to the --

CHAIRMAN WALLIS: You could summarize the Reg. Guide in one slide?

MR. DORMAN: Yes, it gives context for what we're asking for in the Generic Letter.

CHAIRMAN WALLIS: Because the two go out together. Without the Reg. Guide, how can you send this out?

DR. WEERAKKODY: I have a question. When we come in front of the full Committee to talk about the Generic Letter, we probably would need at least a few more slides to do the context unless each member who is not here is already familiar with the issue. I would assume that's the case.

CHAIRMAN WALLIS: We don't need too much history.

DR. WEERAKKODY: Not too much, just we'll focus on the letter, but have a few --

CHAIRMAN WALLIS: Well, they're all

familiar with this to some degree.

DR. KRESS: At least four out of the five are very familiar with this issue.

CHAIRMAN WALLIS: Well, there are six of us here. So there are five more --

DR. KRESS: Five missing, yes.

CHAIRMAN WALLIS: Now NEI wants to come again?

MR. BUTLER: To the full Committee meeting?

CHAIRMAN WALLIS: Yes.

MR. BUTLER: It won't be me. I'll be in San Diego. If you need somebody --

CHAIRMAN WALLIS: I think if NEI comes, what I will be interested in is really, how is industry going to take this and what's going to be the effect? Are they going to be able to do it? They don't know what is in it yet. So, okay, so you can't really comment on something you haven't seen, no. So you don't need to come back.

MR. SNODDERLY: I think we would also need some clarification about future ACRS interactions because I thought I heard Gary Holahan had said this morning that the opportunities for future ACRS review would be when the Generic Letter was final and also when the Reg. Guide, the associated Reg. Guide, was final.

So I think we would want to know, and then I thought I heard Ralph say that we would not necessarily see the Generic Letter again.

MR. ARCHITZEL: Mike, I would clarify that. You always get to see the -- you make a choice. The ACRS makes a choice on it. We distill the comments and provide them because we met on the Generic Letter. When the comments come in, we can meet again.

The point is, this issue, you have to meet on again no matter what. You have to agree on the issue, the generic safety issue, and it could be at the Generic Letter stage.

CHAIRMAN WALLIS: We have to sign off on something, do we?

MR. ARCHITZEL: On the generic safety issue, you have to meet on that, yes.

CHAIRMAN WALLIS: But if there's no change from this draft, no significant change from these documents, I think it could be a very short meeting.

MR. ARCHITZEL: Exactly.

MR. SNODDERLY: Or waive the meeting. We have to come back to you, no matter what, to get a waiver in that meeting.

CHAIRMAN WALLIS: Are you expecting a storm of comments back from industry or are they just going to say, "This is fine," we go out and do it? Have you tested the waters?

MR. ARCHITZEL: No, I think we'll get the comments on the leak-before-break and things like that, but not a storm of comments, no, just the schedule comments.

CHAIRMAN WALLIS: You haven't asked any guidance on the leak-before-breaks.

MR. ARCHITZEL: Well, we've already got a letter that the staff considers regarding a decision --

CHAIRMAN WALLIS: You've already made a decision.

MR. ARCHITZEL: That's our current position.

CHAIRMAN WALLIS: It's the end of this meeting. So I can adjourn? Is that the appropriate word?

MR. SNODDERLY: I think, Graham, yes, and at the beginning of the meeting we had to make two decisions. The first was decide on the need for presentations by the staff at the February 6th date.

CHAIRMAN WALLIS: And we decided, yes, they would do it.

MR. SNODDERLY: And we've decided that they will present from 10:30 until 12:00.

CHAIRMAN WALLIS: About the letter with this or the summary slide on the Reg. Guide.

MR. SNODDERLY: Okay, and then our recommendation to the full Committee would be whether the Draft Generic Letter and associated Draft Reg. Guide can be issued for public comment. Then we would have a Larkinsgram.

CHAIRMAN WALLIS: There may be a further sentence about schedules. That's probably the way it is headed.

MR. SNODDERLY: Okay.

CHAIRMAN WALLIS: There may be members of the Committee who want to write a long letter.

MR. SNODDERLY: Then I think we can adjourn.

CHAIRMAN WALLIS: All right, so we're ready to adjourn. Any objection?

(No response.)

We're adjourned.

(Whereupon, the foregoing matter adjourned at 6:12 p.m.)