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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-review of the 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.