It's not substantiated by data. It is a plausible mechanism, and we could look for important differences, but, again, it won't be a highly faithful representation of actual events.

DR. RANSOM: Well, the L/D limits that you're using in this representation I assume are derived from data that you've taken where you've shot, broke a pipe and had it shoot at directly some insulated component, I guess, right?

DR. LETELLIER: That is correct. And on the next figure is a more quantitative representation of this information.

DR. KRESS: Before you go to the next figure, I'm intrigued by your description of the guillotine break separating, which would form two cones. It seems to me like the conservative assumption would be, if that happens, you take twice this volume, because each cone is going to take out its fraction of the debris.

DR. BANERJEE: At half the pressure though. There's only half the flow. I mean he's looking at impact pressure.

DR. KRESS: I don't think so, because it's just a cone expanding out and you calculate that pressure.

DR. LETELLIER: The correlations do account for that effect because they are a function of both separation and displacement, and I'm not personally familiar --

DR. KRESS: Is there some sort of correlation in there that accounts for that?

DR. LETELLIER: Yes, there is.

DR. KRESS: Okay. So you'll get a different zone factor --

CHAIRMAN WALLIS: When you say, "L/D," is that the pipe size or the break size, the "D"?

DR. LETELLIER: The length is the radius away from the break --

CHAIRMAN WALLIS: What's the "D"?

DR. LETELLIER: -- compared to the pipe diameter.

CHAIRMAN WALLIS: So it's really the break size?

DR. LETELLIER: Yes, assuming a guillotine break.

CHAIRMAN WALLIS: So for a double-ended guillotine break, is it square root of two times the diameter?

DR. LETELLIER: No, it's correlated to the diameter, actually the physical diameter of the pipe.

The next slide, page 18, shows some more quantitative information, so that you have an impression of what the various vulnerabilities are. Higher damage pressures imply a more robust insulation application.

DR. FORD: And this is based on just firing a jet at some things in the laboratory?

DR. LETELLIER: That's correct. Unprotected fiberglass is perhaps some of the most vulnerable material, having damage pressures in the range of 6 to 10 psi.

DR. KRESS: Is old insulation worse than new insulation?

DR. LETELLIER: I can't comment on that. There are aging effects that affect the friability of this material. We have to look at other documents to answer that.

DR. BANERJEE: So Min-K is fiberglass? What is Min-K?

DR. LETELLIER: Maybe I could call on some industry help. Min-K is --

MR. HART: It's a microporous insulation.

DR. LETELLIER: It's a microporous insulation.

CHAIRMAN WALLIS: What does that mean?

Does that mean it's fiberglass?

MR. HART: No, it's microporous. It's a very low turbo conductivity material made of tiny -- take a look at the exhibit -- formed into a thin mat, and they're hollow on the inside.

DR. LETELLIER: In the same category as Calcium-Silicate, which is a low-density, a low-thermal-conductivity material.

MR. HART: Yes, Calcium-Silicate is made from diatomaceous earth. Under the microscope it looks like a lot of little planktonic --

DR. LETELLIER: It represents a class of insulation.

DR. BANERJEE: So the Min-K is microporous silica or what? What is the material? What is the chemical composition of that?

MR. HART: I'm not certain.

CHAIRMAN WALLIS: It's not really Calcium-Silicate which is key here. I mean it depends on how it's bonded. You have these little whatever you called them --

MR. HART: Planktonic.

CHAIRMAN WALLIS: -- planktonic things, but if they're not bonded together, it's not going to have this 160 psi resistance.

DR. LETELLIER: No. In fact, the robust nature of the Calcium-Silicate with the aluminum jacket was actually viewed to be a limitation of the existing BWR data. That's one of the reasons that we requested a test program, in cooperation with Ontario Power Generation, on the next figure.

MR. ROSEN: On that previous figure, is there any thermal lag in these containments?

DR. LETELLIER: I'm not sure the nature of your question. Obviously, there's thermal inertia. For what reason --

MR. ROSEN: Thermal lag, no. There is, and I didn't see it on this list. Is it a bad actor or a good actor?

DR. LETELLIER: I can't comment on that.

MR. ARCHITZEL: Fire-barrier materials, this is insulation material, I guess, is what we're dealing with here, but the fire-barrier material was also assumed to be looked at, but this chart here is just dealing with insulation material.

DR. LETELLIER: And, again, I would repeat that the test programs have never been intended to be comprehensive for every material type.

MR. ROSEN: But there's fire-barrier materials in containments, and they would be blasted apart, too.

DR. LETELLIER: Yes, they would.

DR. RANSOM: What are the units of these pressures?

DR. LETELLIER: Psi, stagnation pressure --

DR. BANERJEE: They're really impact pressures you're talking about.

DR. RANSOM: Is that taking all the velocity head out at that point, putting the thing there, and boom. Is that how you -- how do you measure that pressure?

DR. LETELLIER: I'm not personally familiar with the diagnostics of the jet pressures. They are intended to represent the stagnation pressure on an object, on an unyielding physical object.

CHAIRMAN WALLIS: My intuition says, if I take some household fiberglass and wrap a piece of pipe with it and direct a garden hose at it, it won't come off, and the pressure there is probably 40 psi.

DR. RANSOM: These must be one-half r-squared, I assume. Otherwise, they would be at least the containment pressure plus.

DR. BANERJEE: But if you put fire hose water on it, it probably will --

MR. SNODDERLY: Excuse me, Bruce. This is Mike Snodderly.

I notice we're on slide 18 and you have 48 slides that you would like to present.

CHAIRMAN WALLIS: There can't be 48. Are there really 48?

MR. SNODDERLY: Forty-four, sorry. What I would like to suggest is maybe we could take a few minutes just to maybe try to prioritize what we want to try to look at between now and, say, 4:30, quarter of 5:00, because I want to make sure that we give John Butler and NEI an opportunity to let the Committee know what they're doing.

For example, I notice that, when I read through the Reg. Guide, one of the big analytical models that jumped out at me was under "debris transport," 1.334, an acceptable analytical approach to predict debris transport was NUREG/CR-6772 and 6773. I noticed that your slide 31 goes over those assumptions. So I think the Committee would be very interested in going over that.

Obviously, I think they would like to have some understanding of the debris transport chart, the work that you show in slides 27, 28, and 29.

So I would like to put it to suggest to

you, what do you think, to get to the point where in your conclusion, where you say, "These are the acceptable analytical models that we believe exist today," and the basis for them, and maybe summarize.

Does that sound fair, Dr. Wallis, or what do you think?

CHAIRMAN WALLIS: Well, I'm just thinking that this is all fascinating stuff, and we could go on all day, but I'm not sure it makes any difference to the conclusion. I mean this Reg. Guide can go out for public comment whether or not any of this makes any sense, because someone's got to do the analysis. This really requires it.

If we're going to have to review whether or not we believe your analysis, that's a whole different kettle of fish.

DR. LETELLIER: I think the purpose of this talk is to demonstrate that methods have been offered and that there is a technical basis to support the Reg. Guide.

CHAIRMAN WALLIS: There's no way that in this meeting we're going to bless these methods. We need to study the NUREGs and all that.

MR. SNODDERLY: Right, you're right, Dr. Wallis. The purpose is just to determine whether they're sufficient to be released now for public comment.

I think what I would like to accomplish is for the Committee to have as good an understanding as possible in the time remaining of what the methodology is that the staff has developed. So that when we hear from NEI, we can get an understanding of their analytical approaches or where they plan to go.

Then, again, as the Reg. Guide goes out and public comment occurs, when it comes back to us, we'll have some idea of what the state-of-the-art of the analytical methods are and where they'll go, and perhaps we can have some input into that.

CHAIRMAN WALLIS: Well, Mr. Butler is here, is he?

MR. BUTLER: Yes.

CHAIRMAN WALLIS: Would you be willing to stay later? If we go on for another half-hour with this, would that be all right with you?

MR. BUTLER: That's fine.

DR. LETELLIER: The questions of the Committee have been very relevant, and you have anticipated much of the presentation material. So if there are areas you would prefer to focus on, please let me know.

Continuing a little bit more quickly with slide 19, we did attempt to remedy the deficiency in Cal-Sil data by starting a research program with Ontario Power Generation. They had a test facility of a limited volume --

MR. ROSEN: You might want to click the slide. You're on 18.

CHAIRMAN WALLIS: Yes, let's move along now.

DR. LETELLIER: Thank you.

The test conditions are listed in the upper righthand corner. It was a small-volume tank with a fixed nozzle opening and an initial pressure somewhat lower than a PWR blowdown condition at a temperature somewhat lower.

The blowdown history from the test apparatus is shown in the lower curve, the red curve, and predictions --

CHAIRMAN WALLIS: Of course, RELAP is perfect.

DR. LETELLIER: Thermal-hydraulic predictions of the PWR are shown in black.

CHAIRMAN WALLIS: Oh, I thought it was the red one.

MR. ROSEN: The testing must be wrong.

CHAIRMAN WALLIS: I thought it was the red one.

DR. KRESS: What is the vertical axis? I can't read it.

DR. LETELLIER: These are pascals.

DR. KRESS: Pascals?

DR. LETELLIER: The pressure versus time.

CHAIRMAN WALLIS: I thought the RELAP prediction for the test set was perfect.

DR. KRESS: It is.

CHAIRMAN WALLIS: Yes, so let's move ahead.

DR. LETELLIER: I'm illustrating the difference between the test configuration and the actual PWR blowdown, and the motivation for actually scaling the debris generation data for the effects of --

CHAIRMAN WALLIS: They direct this yet at a typical pipe?

DR. LETELLIER: That's correct.

And a couple of figures are shown, photographs, in pages 22, 23, and 24.

CHAIRMAN WALLIS: It's a before and after picture?

DR. LETELLIER: Yes. The basic

conclusions are shown on page 21, which emphasizes that the OPG data had to be rederived or modified to account for the actual PWR accident condition.

The conclusions show a slightly increased zone of influence compared to damage zones derived in the BWR study. Again, for this accident scenario, we have a two-phase jet blowdown with important momentum effects in the droplets.

Zone of influence increased slightly for both Nukon and Cal-Sil, and we observed a higher fraction of small material or fines compared to earlier tests.

CHAIRMAN WALLIS: Are you going to show us the before and after very quickly?

DR. LETELLIER: Page 22 is the test item as applied in a jacketed fashion.

CHAIRMAN WALLIS: It's blasted head-on by a jet?

DR. LETELLIER: That's right, on the center line. It's positioned on the center line.

DR. RANSOM: Is that the jet over on the left side?

MR. ROSEN: The jet comes in perpendicular to that.

DR. RANSOM: Well, that orange thing over there, is that a nozzle?

DR. LETELLIER: One of these two pipes represents the nozzle. I'm not sure which one.

MR. ROSEN: The one below will miss it.

DR. LETELLIER: The perspective is difficult to see in the photograph. I believe this test article is positioned on the jet center line.

MR. ROSEN: There's an arrow there on the line, isn't there?

DR. RANSOM: That's the target.

MR. ROSEN: That's the target, I should say.

DR. RANSOM: I see, "X" marks the spot, right?

MR. ROSEN: It sure looks like it hit the spot.

DR. LETELLIER: You will also notice the orientation of the jacketing, so that the overlap on the stainless steel jacket is exposed to the jet. That represents a condition of vulnerability as opposed to rotated or oriented away from the jet.

This is a Calcium-Silicate blanket. Again, the nature of this insulation is basically low-density concrete. It has a very low thermal conductivity. It's very easy to mold and apply in different configurations.

After the test, you can see the extent of damage.

CHAIRMAN WALLIS: And then you collected all the pieces.

DR. LETELLIER: And then they collected the pieces, and that's shown on page 24, at least the range of debris that could be recovered. The remainder that was not recovered is assumed to be in the fine, very transportable fraction, and a crude mass balance was attempted to proportion --

MR. ROSEN: It's in Lake Ontario.

DR. BANERJEE: How much of it went into fines compared to the total mass?

DR. LETELLIER: If we look back on slide 21 --

DR. BANERJEE: Oh, it's there? That's fine.

DR. LETELLIER: Slide 21.

DR. BANERJEE: You don't have to go back.

DR. LETELLIER: Approximately 30 percent of the material was generated in fine debris. Prior to this study, there had been no observed damage for Cal-Sil in jacketed configurations. We felt that those tests had been flawed, and so that's the reason we attempted to gain more empirical evidence.

DR. BANERJEE: Now this facility of Ontario Hydro or Power Generation is available for other tests as well or just --

DR. LETELLIER: We actually had a quite extensive test program planned with them, but we weren't able to conduct it to fruition because of some safety concerns with their thermal-hydraulics lab. So it was not made available to us as freely as we hoped.

DR. RANSOM: I notice some of the data, the fields of damage were like 12-D and you were using 7 as the limit before. How do those two compare?

DR. LETELLIER: I'm not sure what you're --

DR. RANSOM: Well, on slide 21 you have slightly increased zone of influence, 12-D versus 10-D, and before you were quoting 7-D, I thought, as the maximum L/D.

CHAIRMAN WALLIS: It's the affected sphere, though, isn't it?

DR. LETELLIER: Again, that sphere was meant as a representation to explain the vulnerabilities of different insulation types. I wouldn't try to relate it quantitatively.

DR. RANSOM: What values are used, then,

I mean in your calculations? Are they the ones that you obtained from these experiments?

DR. LETELLIER: Yes.

DR. RANSOM: Okay.

DR. LETELLIER: Yes, the destruction pressures are based on observation. That's the only basis that we have.

To clarify, there is no predictive model of microphysics for debris generation for an impinging jet.

DR. RANSOM: Sure. Well, I was wondering where the value 7 came from that you talked about before.

DR. LETELLIER: I was simply counting the tick marks on the graphic.

DR. RANSOM: Okay.

DR. LETELLIER: Yes, it was meant as a representation.

CHAIRMAN WALLIS: Yes, but somebody has to put numbers on it if they're going to calculate anything.

DR. LETELLIER: And that has, indeed, been done in a tabular way.

Moving on to blowdown/washdown on page 25, again, we have no truly predictive model to determine where this debris will go.

CHAIRMAN WALLIS: Well, the containment spray does a pretty good job of washing it down, doesn't it?

DR. LETELLIER: Yes, it does, but it is also true that it does not impinge on every vertical surface. There are significant fractions that are sheltered from direct spray, and in that case you have steam condensation in rivulet formation that can wash debris to the floor.

Because we have no predictive capability, we are looking at the conditions necessary for transport, the updraft velocities, for example, and the impingement of containment spray. We're looking at the water balance calculations provided by our volunteer plant, looking at the hold-up in pools on each floor of containment, and where the most likely return paths are; for example, stairwells and designed drainage features.

This information is being incorporated into a logic chart, very much like an event tree for an accident analysis, where we try to make defensible, conservative decisions about the fraction of each size of debris type that's either retained --

CHAIRMAN WALLIS: It seems to me you have no basis for it whatsoever. I mean, if you look at a stairwell and you try to predict how many of these rocks stop on the treads of the stairs, you can't do it just by talking about it like this.

DR. LETELLIER: There is actually empirical evidence of retention by gradings, actual debris --

CHAIRMAN WALLIS: So you put in actual numbers here?

DR. LETELLIER: Where we have information, of course, we do, and where the information is lacking, we make conservative assumptions. As I pointed out earlier, the retention factors are less than 50 percent.

CHAIRMAN WALLIS: At least it gives you a framework for filling in.

DR. LETELLIER: It does, and as I tried to make a list here, it lets you assess the degree of conservatism that can be compared to the plausibility of these physical mechanisms.

This is on Figure 27, which is a schematic of the logic chart, but in the next two pages, 28 and 29, you can see that you can get carried away with this level of detail.

CHAIRMAN WALLIS: It's the debris that

gets carried away.

(Laughter.)

DR. LETELLIER: Touche!

CHAIRMAN WALLIS: Wow, it's an eye test (referring to the chart).

DR. LETELLIER: This type of analysis is very easy. The PRA tools have been adapted to look at the various transport mechanisms.

CHAIRMAN WALLIS: Okay.

DR. LETELLIER: Please don't spend any time studying this. It's simply an illustration.

CHAIRMAN WALLIS: Yes.

DR. BANERJEE: But do you actually use something like this?

DR. LETELLIER: We are actually using this to assess its value for our volunteer plant analysis. We're trying to --

DR. BANERJEE: Do you think this level of detail is appropriate? I mean, it's like having too many significant figures in a number.

DR. LETELLIER: Well, as I said, we've already learned the key element.

DR. BANERJEE: Right.

DR. LETELLIER: We've discovered that we cannot rationalize a reduction factor of more than 50 percent. It's not a factor of a hundred or a thousand, as some people would like to claim, actually, that the fine particulates will be carried to every surface in containment, and they will never come down. We cannot rationalize that from a conservative engineering perspective.

DR. BANERJEE: But do you need this level of detail to do that?

DR. LETELLIER: The answer is no.

DR. BANERJEE: I mean, is this illustrative or it is something which is in some NUREG that somebody can attack and say, "This doesn't make any sense."?

DR. LETELLIER: This is illustrative and it's also educational, if you will. It lets the plants prioritize where to put their analysis effort.

MR. ROSEN: You know, it's not that educational to me because I can't read the event states at the top. Would you just sort of read a few of them to me, so I know what they say?

DR. LETELLIER: Let's go back to the schematic.

CHAIRMAN WALLIS: He can't read it, either.

(Laughter.)

MR. ROSEN: Which one are you looking at? Right now you're --

DR. LETELLIER: This is on page 27.

MR. ROSEN: Well, you've got page 26 up there.

DR. RANSOM: It's slide No. 27.

CHAIRMAN WALLIS: So there's bullets would appear as stages in this tree diagram?

DR. LETELLIER: It basically walks you through the disposition of a debris fragment depending on its size, whether it's initially deposited on the floor, on a vertical surface, on a horizontal surface; whether it's impacted by sprays, direct impingement, or condensation; whether it is subject to secondary motion through pools on elevations, different elevations of the plant, and, eventually, whether it's deposited into the pool.

MR. ROSEN: And that's what this ghastly one does?

DR. LETELLIER: That's the end state.

MR. ROSEN: It takes it from one step to another to another, to a third perhaps --

DR. LETELLIER: That's correct.

MR. ROSEN: -- and, ultimately, down into the sump?

DR. LETELLIER: That's correct.

DR. BANERJEE: So you've done more details of each of these?

DR. LETELLIER: Yes. And what we've learned by this exercise is that there's not a great return to be gained by the plants investigating this in detail.

For example, you mentioned earlier, if you did a full computational fluids model of a break jet in a specific location, you might argue that there was very little debris generation for a particular break. I don't think you could get the same savings in this aspect of the accident sequence, largely because of the uncertainty in the initial conditions. You physically just don't know where every piece of debris will go.

You can talk about it generically, and you can argue it conservatively, but, ultimately, as we sum up all the end states in this event diagram, we see that between 70 and 90 percent of the debris eventually comes back to the pool.

MR. ROSEN: Well, it's a great simplification.

CHAIRMAN WALLIS: Then let's design for a hundred percent and forget about it.

MR. ROSEN: Yes, it makes sense. It's very valuable. It's a great simplification. You don't have to trace each particle's path. You know where it started and you know where it's going to end. You're not that interested in what it does in between.

DR. LETELLIER: But the key point is we needed to perform this exercise to reach that conclusion. Now it's available for the industry's evaluation.

Moving on to pool transport on page 30 and 31 --

DR. BANERJEE: So are you going to say in the Reg. Guide or is one of the accepted things going to be, if you say 80 percent is going to get down, fine; if not, do you prove that below whatever this --

CHAIRMAN WALLIS: If they can't prove it, they're supposed to assume 100 percent, aren't they?

DR. JAIN: That's what we have in the Reg. Guide right now.

DR. LETELLIER: That default position is stated in every aspect of the accident scenario in the Reg. Guide.

CHAIRMAN WALLIS: Okay, can you move along quickly through this one?

DR. LETELLIER: Certainly. For pool

transport, we were very concerned about debris mobility in the pool.

CHAIRMAN WALLIS: Yes, because it hides in corners. It hides in stagnant areas.

DR. LETELLIER: It does. There is a potential that it may.

Initially, we needed to characterize the mobility of debris types, whether it's a paint chip or a crumble of foil or a flock of fiber that's one inch or five inches. So we conducted a separate effects test in a flume to look at incipient flow velocity, settling rates, et cetera.

The second phase of analysis was to introduce this debris into an integrated tank. It was a scale model, a one-tenth scale, of a PWR configuration. We looked at the disposition of debris both during fillup and also at the recirculation phases.

It was difficult to preserve momentum scaling in this study, so we looked at it as an integrated test that introduced rotational flows and opportunities for settling.

In fact, we did collect debris on both a vertical and a horizontal screen, and the most important conclusion was that, perhaps not surprising, is that individual fibers are indefinitely suspended, and they eventually migrate to the screen.

We also observed that in regions of splashing, where water would return to the pool, there is a degradation mechanism that will continue to shred flocks of insulation that actually reach that zone. That's a very important thing to learn.

MR. ROSEN: Because it floats?

DR. LETELLIER: No, because of the recirculation patterns around a splash, material is actually collected; it's drawn towards that area. An initially large flock of one inch perhaps, which might remain stationary, if it's entrained in the splash, it will be shredded into individual fibers.

CHAIRMAN WALLIS: Something that white water canoers have experienced, too.

MR. ROSEN: Getting shredded?

(Laughter.)

DR. LETELLIER: That's correct. So the primary conclusion of the integrated tank test is that velocity maps and regions of localized turbulence are important to assessing the final transport fraction of debris in the pool.

On page 32 are some computational fluid dynamics results of a splash introduced in one of the steam generator compartments. That gray circle represents splashing water on the floor. We're looking at the velocity maps that are generated to determine whether or not it exceeds the incipient flow velocity for different debris types.

DR. BANERJEE: Is this a plan view?

DR. LETELLIER: It is. It is a plan view at the floor level of a representative of --

CHAIRMAN WALLIS: So you're saying the red area gets scoured? Is that what you are saying?

DR. LETELLIER: That's correct.

DR. KRESS: That depends on the amount of flow going into that splash area?

DR. LETELLIER: Yes, it does, and it's very geometry-specific. That's the other conclusion to take.

DR. BANERJEE: But you just integrated over the height, right? You didn't actually do a 3-D CFD simulation?

DR. LETELLIER: Yes, this is a 3-dimensional pool calculation, and this is the slice at the floor level.

DR. BANERJEE: I see.

DR. LETELLIER: There are representative horizontal velocity components at the floor.

DR. BANERJEE: It seems overkill. But, anyway, go ahead.

MR. ROSEN: So tell me, what does it tell me, all of the orange?

DR. LETELLIER: The figure on the right has been scaled to a maximum velocity of .2 feet per second. From the individual effects test, that's sort of a rule-of-thumb threshold for debris movement. If it exceeds .2, it's very likely to be mobile. If it's less than .2, there's an opportunity for settling.

So you can see that in the cavities opposite the break there is an opportunity for settling, but much of the remainder of containment is turbulent and it will be moving debris.

CHAIRMAN WALLIS: Yes, more than often.

DR. LETELLIER: And that's exactly the perspective that we hope to use. We're not hoping for a predictive capability of debris transport. We're looking at the fractions of containment area that are subjected to potential transport and applying that in a crude way, a 50 percent, a 30 percent --

CHAIRMAN WALLIS: Well, you're also getting expertise with which to review whatever industry gives you.

DR. BANERJEE: Of course, if you had two

sumps now, you would have one in a low-flow and one in a high-flow area, right?

DR. LETELLIER: If they had the luxury of redesigning with forethought, perhaps they would. Every containment design has a single-sump location that's more or less co-located. There are examples of multiple-sump outlets, but they are on one side of containment. They are in one location.

DR. BANERJEE: But both trends start basically from the same area?

DR. LETELLIER: That's correct.

DR. RANSOM: Where is the sump in this case?

DR. LETELLIER: The sump is --

DR. RANSOM: And how deep is the layer of fluid?

DR. LETELLIER: In this simulation I believe it is 24 inches, which is in the range of a plausible pool depth. Again, it is not a perfect scaling, but it's an example of an analysis technique that could be used.

CHAIRMAN WALLIS: Can we move on now?

DR. LETELLIER: The next slide just simply shows the dependence on geometry. The patterns are completely different if the break is in a different quadrant.

CHAIRMAN WALLIS: So you're going to run 10,000 Monte Carlo simulations?

(Laughter.)

DR. LETELLIER: We hope to run four, one for a break in each steam generator cavity, and look at the fractions to decide whether they're substantially different or not.

Slide No. 34 is a simple schematic of how the information from velocity maps and separate effects testing can be combined to estimate an ultimate transport fraction in the pool. Again, these conclusions will be cast in the form of 30 percent, 50 percent, based on the intuition that we've established from calculation.

You can read some of these observations regarding CFD. I would just remind you that we are not attempting to do a predictive model of debris transport. We're not looking at the microphysics of drag, settling, entrainment. We are trying to use this as a tool for velocity maps.

DR. LETELLIER: You're using it like PRA, to gain insights and --

DR. BANERJEE: But you have some experiments, right? I mean, you're not depending on this CFD code?

DR. LETELLIER: That's correct. We've actually run calculations and bench-marked them against our tank tests under the test conditions.

DR. BANERJEE: But, you know, you can make a CFD code fit anything. So you need some experiments.

DR. LETELLIER: That's correct, and we did observe good, qualitative agreement between the models and the tank experiments.

The reason that we're not pushing for, again, the reason we're not trying to develop a predictive capability is captured in the last bullet: The uncertainties in the location and the timing of debris introduction, they just limit the need for high-fidelity modeling. We simply don't know when and where this material will return to the pool.

CHAIRMAN WALLIS: Now this next bit, head loss, ought to be the easiest part.

DR. LETELLIER: From the point of view of testing, I believe that is accurate. There is a substantial amount of information in the literature regarding head loss of various debris compositions, bed thicknesses, et cetera.

In the BWR study in NUREG-6224 that

information was captured in a correlation based on theory for porous media and validated against experiment for the correlation coefficients, for very specific test conditions.

Some of the features of importance are the water temperature for dynamic viscosity, the media, the composition of the bed, its thickness, and the flow velocity through the bed. Those are all important parameters of the correlation.

CHAIRMAN WALLIS: The mysterious one looks like page 40 -- other than what you might expect.

DR. RANSOM: What is "UNM"?

DR. LETELLIER: University of New Mexico.

DR. RANSOM: Okay.

DR. LETELLIER: The Civil Engineering Department has been helping us conduct these tests.

CHAIRMAN WALLIS: What is this page 40? Can you go to that?

DR. LETELLIER: Slide No. 40 is an illustration of the head loss correlation applied over a range of debris volumes, fiber volumes. You can see that there is a sharp transition at low fiber volumes where the bed begins to deteriorate. Essentially, you punch holes in the fiber mat, and the flow starts to escape through the screen. And that's the reason that the head loss does not --

CHAIRMAN WALLIS: It depends very much on the structure of the fibers. Some of them are reinforcing. They squash down and they may get tighter. Other ones open up.

DR. LETELLIER: Bed compaction is --

CHAIRMAN WALLIS: The fibers bend around the screen, is what happens, isn't it, here?

DR. LETELLIER: Yes, that's the effect that you're seeing.

MR. ROSEN: You're going online.

MR. ARCHITZEL: Focus on that slide with the perspective of removing all the fiberglass can still be a problem or can create a problem.

CHAIRMAN WALLIS: This indicates it isn't as simple as you might think. You need more fibers to reduce the pressure?

DR. LETELLIER: There is a counterintuitive behavior where thick beds are actually more porous. Thick beds of fiber can provide more flow area than a thin bed, simply because of the interstitial gaps between the fibers. If they are not compressed, as he mentioned, they will allow more water to pass through.

A very thin mat that's arranged in a very regular fashion, and the interstitial gaps are blocked by particulate, is very effective at ending flow.

CHAIRMAN WALLIS: I think there's a hysteresis with this. I mean, if you have laid down a very uniform bed without holes in it, you get a different curve, and if you begin to build it up and then it breaks down, then you build it up some more. There's a time effect with this whole thing.

DR. LETELLIER: That effect is very evident. I actually deleted a slide that showed that.

The test that we're interested in is taking, for example, a one-inch mat of fiber and gradually increasing the flow velocity so the bed compresses. As we relax the velocity, the bed does not re-expand. There is a hysteresis effect.

DR. BANERJEE: Does this contain any particulate matter as well or just fiber?

DR. LETELLIER: The various curves represent the amount of particulate that is present: 300 pounds, 200 pounds, et cetera.

The qualitative behavior is the same.

DR. BANERJEE: I can't get a feel for what those pounds mean, but is that sort of -- how many feet squared are we on?

DR. LETELLIER: I'm not sure exactly what the conditions were for this calculation. It's offered as a representation of proper use of the correlation. Between 100 and 300 pounds is a reasonable value for particulate in PWR containment, and there's work currently ongoing to quantify that.

DR. BANERJEE: But that would depend on the surface area of the filters, right?

DR. LETELLIER: Very much so.

DR. BANERJEE: Okay.

DR. LETELLIER: The head loss effect depends greatly on the surface area.

CHAIRMAN WALLIS: Okay, can we move on?

DR. LETELLIER: I think that you've gotten a good impression of the detail to which we have examined the various aspects of the accident sequence. Ultimately, each component has to be integrated into a vulnerability assessment from beginning to end, that is, from debris generation to ultimate head loss.

The final slides on page 42 illustrate some of the tools that LANL has used to gain insights into these effects and the methods that are being offered to the industry as a starting point for their own analysis.

In particular, I would point you to bullet two, the Knowledge Base Report, which is forthcoming, is a compilation of all existing test data and analysis methods.

Bullet 3 is a comprehensive plant analysis which is currently ongoing to help us gauge appropriate level of detail and help us assess the validity of plant responses to the Generic Letter.

CHAIRMAN WALLIS: If every plant had to do as much work as you've done, it would be much cheaper just to make a bigger screen.

DR. LETELLIER: Certainly, but, actually, I don't think the NRC would have been comfortable making that judgment unless we had gone to this level of detail.

DR. BANERJEE: But would a bigger screen work if there was a lot of fiber? I mean, that's really the bottom line here.

DR. LETELLIER: Of course, there are limits to engineering solutions.

DR. BANERJEE: Right.

DR. LETELLIER: And if they simply don't have space, they will have to take advantage of other concepts. For example, in the BWR screens, they arranged stacked disks or crenelated surfaces to allow for perpendicular flow components. The bulk flow moves in one direction; the filter draws flow in a transverse direction, and that establishes a very low penetration velocity, which in turn gives you very low head loss.

So there are important design considerations that should be incorporated into --

CHAIRMAN WALLIS: Is it a fluted type of screen?

DR. LETELLIER: I'm sorry?

CHAIRMAN WALLIS: A fluted sort of screen?

DR. LETELLIER: You can imagine different geometries.

CHAIRMAN WALLIS: Folded screen?

DR. LETELLIER: Yes, folded arrangement, stacked disks. Your imagination is the only limit.

I would point out one important difference between -- the BWR screens are primarily perforated plates. They have circular openings stamped into stainless steel. PWR screens are primarily wire mesh, rectangular wire mesh arrangements.

The head loss testing that we performed demonstrates that the correlation is applicable to both configurations, and we are refining the coefficients of this correlation to apply, best apply, to Calcium-Silicate, which wasn't available before and also mixed debris beds of Calcium-Silicate and fiber and Calcium-Silicate and RMI.

DR. FORD: Bruce, you mentioned the correlation between BWRs and PWRs, and you've been three years doing this work for PWR steam generator breaks. How much more work would it be to do a head penetration on a PWR, if a head penetration, if a CRDM housing was ejected, and you had damage to the insulation on the top head?

DR. LETELLIER: I think it was already mentioned that that scenario would be treated as a medium-break LOCA, and it would be --

DR. FORD: Maybe I was not here at the time. Sorry.

DR. LETELLIER: Yes. Depending on the break opening, it would be very much the same, perfectly analogous as far as debris generation and transport.

DR. FORD: And the data to support that?

DR. LETELLIER: Would be the blowdown calculations from a code like RELAP, thermal-hydraulics, in comparison to debris-generation data that were produced.

DR. FORD: Okay.

CHAIRMAN WALLIS: From the point of view of cost-effective regulation, we've seen that one could have made a decision some years ago not to do all this work, but simply to make a decision. This would have improved safety. Now nothing is being done while the work is being done. So there has been no effect on safety while all this has been going on.

DR. LETELLIER: I will say one thing. This is a typical level of detail that was pursued in the BWR resolution. As to the regulatory decisions, I'll defer that comment.

MR. LEHNING: Just before we go through -- this is John Lehning from NRR -- before we can pursue in a regulatory way any issue, we have to prove that it's credible and that we have a basis to go forward. That's kind of what --

CHAIRMAN WALLIS: This is integrated effects of five years of CFD, which is 170 times what you thought it was. It's a pretty big safety impact. I'm sure that's exaggerating, but if you look at the cost of not doing anything all that time, it's probably significant.

MR. LEHNING: Some of the work that we did was used to get that risk analysis and to do that parametric studying and to get those numbers. So we didn't have that at the beginning, you know, way back five years ago.

MR. DORMAN: In fact, if I remember correctly, we treated the BWRs first based on the operating experience that had been observed, and there was some judgment at that time, absent the information that's been developed here, that there was not an expectation that this was going to be a big problem for the PWRs. So that some of the information that's been developed in the GSI-191 program regarding debris generation and transport, that has brought us to where we are.

MR. ARCHITZEL: But I would come back to that reg. analysis on the USI A-43. Those costs were not unsubstantial at that time. There were benefits at that time, and they were fairly significant. The decision was made the cost/benefit didn't warrant backfit, and that's the flipper. I mean we had a cost/benefit done already. It was a good benefit and it was a very expensive fix.

CHAIRMAN WALLIS: Does the Subcommittee have other questions for this group of presenters?

MR. ROSEN: What's this last slide that's 43? What does it tell me?

DR. LETELLIER: As I said, ultimately, each component of the analysis has to be integrated together. If you look at debris generation, this figure on 43 looks at the vulnerability of a specific sump to a challenge of various combinations of fiber and particulate. This is the threshold for failure where they exceed their NPSH margin.

If you combine this failure threshold with all of the debris sources, you can generate the last figure, which shows you the range of pool -- well, of total transport that would be required to induce failure of the screen.

CHAIRMAN WALLIS: If you have no fibers at all, though, to get back to Sanjoy's point, then the product will just go through?

DR. LETELLIER: Yes, they will.

CHAIRMAN WALLIS: So then you have no fiber. Then you have infinite number of particles, and it doesn't make a difference. Some of these are low fiber volume.

DR. LETELLIER: Again, these dots on this Figure 44 do not represent particulates. They represent scenarios.

CHAIRMAN WALLIS: No, I was looking at the one before, 43.

DR. BANERJEE: It would be interesting to see what the back-up slides were.

(Laughter.)

DR. LETELLIER: You're right, of course. At the far lefthand corner --

DR. BANERJEE: It's a log scale, Graham.

CHAIRMAN WALLIS: I know we never got there, but, I mean, you get a very small amount of fiber when you get --

DR. LETELLIER: At the far lefthand corner of this figure --

CHAIRMAN WALLIS: That's ten to the zero feet cubed there? One cubic foot?

DR. LETELLIER: That's correct.

CHAIRMAN WALLIS: What's the scale here? There's a blip. Units of ten? A tenth of a cubic foot? I don't believe it.

DR. LETELLIER: This is a representation of a screen. Depending on the area and the approach velocity, there are plant configurations that could be blocked with one cubic foot of fiber and some amount of particulate. That's not a generic statement. That's very plant-specific.

CHAIRMAN WALLIS: It's true, okay.

DR. LETELLIER: Now your comment about the threshold, at the far left there is a missing line that essentially extends vertically upward.

CHAIRMAN WALLIS: It falls straight down.

DR. LETELLIER: And that represents the minimum fiber necessary to induce the thin bed effect.

MR. ROSEN: I'm having trouble seeing the exponents. On the bottom what is that, 10 squared or --

DR. LETELLIER: Ten to the zero. That's one cubic foot.

MR. ROSEN: At one cubic foot. Now go up and intersect the line. It says that -- what is that, a tenth of -- at one cubic foot of fiber you get a tenth of a cubic foot of particulate.

CHAIRMAN WALLIS: That doesn't make any sense. It doesn't make any sense. It's a pocketful. I mean it's crazy.

MR. ROSEN: Compared to the thousands or hundreds at least of cubic feet that are in the containment and are affected by these events we're discussing.

DR. LETELLIER: Again, it's not worthwhile to dissect this particular example, but --

CHAIRMAN WALLIS: Well, I think we should because we're establishing credibility.

DR. LETELLIER: It is illustrative of plant conditions with very high approach velocities and very small screen areas.

MR. DORMAN: Yes. I think when you translate an actual relatively small screen area to something on the order of an eighth of an inch of fiber bed over that area, the point here is that it takes a relatively small volume of fiber to create sufficient bed to then trap the particulate and have substantial head loss.

MR. ROSEN: The only thing I'm taking away from this chart is, if you have a very, very adverse screen configuration, sump configuration, you can plug it with a little of fiber and a little of particulate.

DR. LETELLIER: That is correct, but the point of this slide is to demonstrate that the licensees need to assess their own vulnerabilities in much the same way. They need to have an understanding of transport and head loss in order to respond to the Generic Letter.

CHAIRMAN WALLIS: This is for an existing screen and a real reactor, a real containment, this figure?

DR. LETELLIER: No.

CHAIRMAN WALLIS: No, it's not, no.

DR. LETELLIER: This is a representation of a screen that was taken from the parametric case evaluation.

CHAIRMAN WALLIS: Okay.

MR. DORMAN: But it is typical of a screen that may be found out in an operating reactor today.

CHAIRMAN WALLIS: It is?

DR. LETELLIER: This is a particular case study from the parametric report.

DR. BANERJEE: How many square feet -- because the volumes don't tell me anything unless I know how big the screen was here. How big was it?

DR. LETELLIER: I don't recall.

DR. BANERJEE: I mean, if you have a screen this big, of course, one-foot square is a lot.

DR. LETELLIER: There are some cases of very small screen areas like 10 to 12 square feet.

DR. BANERJEE: I see. Okay.

CHAIRMAN WALLIS: Okay, anything else?

DR. LETELLIER: Thank you for your interest and your time.

CHAIRMAN WALLIS: We would like to thank you all for very interesting presentations.

Would the Committee be willing to continue now, just keep going? I'm sorry to keep you waiting.

MR. BUTLER: No problem.

MR. ROSEN: I think that was a good presentation. It was very useful. Thank you.

MR. BUTLER: May I use this overhead projector?

Shall we proceed?

CHAIRMAN WALLIS: Yes, please.

MR. BUTLER: First off, my name is John Butler. I'm a Project Manager at the Nuclear Energy Institute in Washington.

What I would like to do is give you a little bit of an overview of what the industry activities are in this for GSI-191.

One of the points I want to make from the start is that we have been active observers in the NRC activities in this area, enough to become convinced ourselves that this is really an issue that we need to take on. So we are actively pursuing addressing the issue at PWR plants, independent of the NRC activities to issue a Reg. Guide or a Generic Letter.

Our activities, our schedules have been developed independent of that. The schedules that the staff has pursued in developing and issuing that guidance has the potential to impact our already-stated schedule, but that is something we'll just have to evaluate as things progress. But I did want to make the point that we are taking this issue seriously.

CHAIRMAN WALLIS: So you're taking the lead? It must mean that Los Alamos is behind?

MR. BUTLER: Consider it a baton pass-off. Research had the lead, ran with it, and has passed the baton to us. The end result is we have to finish the race, and I think at some point NRC is going to stop and turn it over to us.

What I'm going to try to cover in a very --

MR. ROSEN: I don't think so. I think the utilities have to finish the race.

MR. BUTLER: I'm speaking for them.

MR. ROSEN: But they have to do something in the plants.

MR. BUTLER: Yes.

What I would like to do is address, in a general fashion and fairly quickly, who is involved in this activity, what activities we currently have underway and what we're trying to accomplish, and when we expect to have that completed.

First off, who is involved?

CHAIRMAN WALLIS: The usual suspects.

(Laughter.)

MR. BUTLER: Well, the important thing to point out here is that it's not just NEI, a typical

NEI task force where we go off and grab some people and we sit around and talk. We've actively involved all three of the PWR owners' groups. They have their own resources. In fact, it's the owners' groups that are actively funding the development activity for this.

We also, as almost in an advisory capacity, have a Task Force that has involvement of, again, PWR utility representatives, EPRI. We also have, at their request, allowed EDF to join our activities.

You touched on it briefly in the prior discussions, what the international activities are. The French are actively involved, and they are very actively trying to see what the U.S. is going to do. It's not clear to me right now who is going to take the lead in this resolution, but, again, our activities have to run independent of what the international community is doing. We have to proceed to close this issue out.

But we are very interested in following what the French and other European nations or other international representatives are doing to address this issue. So we're trying to stay connected with that. Having somebody from EDF on the Task Force helps us there.

We have a number of consultants who have expertise in various areas actively participating on the Task Force, and we're thankful for that because their participation is done gratis. We're lucky to have them participate.

What I have tried to do here is kind of outline that there's three general areas of activity that are currently underway. The first area there is really trying to get our hands around all the data that has been collected, all the research we've conducted, some of it contradictory to prior research. So it's a lot of information, a lot of research, a lot of data.

CHAIRMAN WALLIS: So you call NUREGs data, too? I mean, they're information.

MR. BUTLER: Information, yes. I mean a lot of the NRC-funded activity and test data is documented as part of NUREGs.

A lot of research that has been done is not directly applicable to the conditions of PWR, so there's clearly an effort in evaluating that data to make sure that it's directly applicable or the range of applicability to PWRs, and where it's not, what of that information can be used. So there is a significant effort just taking the data that's available and assessing how we can best use that data.

Beyond the test data, there's also a need to better understand PWR plants. You're already familiar somewhat with the guidance we issued this past spring for plants to go out, as part of our analysis, to assess what the debris sources are, to just get a better understanding of their containments.

A lot of the information, a lot of our understanding was based simply on their design drawings, and this provided an opportunity or the impetus to go into their containments and either confirm that their understanding of their plant was correct or, where it wasn't, to correct it.

So knowing what the plants have in their containments is needed in order to, once we have the evaluation methodology, to then jump-start the final step, which is to implement the resolution on a plant-specific basis.

The main task, as you might expect, is developing the methodology itself. I guess I'm getting ahead of myself.

CHAIRMAN WALLIS: What do you see for a methodology? Do you see sort of a general computer program where you fill in bits that are characteristic of your particular plant and then the machine runs and out comes some number at the end which says you're okay or you're not?

MR. BUTLER: No, that would be a possibility if there were more similarity among all the PWRs, but the condition that we have is there is a very wide variability of the PWRs.

CHAIRMAN WALLIS: That's what concerned me from the start, when we looked at this the last time, is that every utility is going to have a different situation. You can see all the amount of work that Los Alamos has been doing, and you can't do all that for every plant.

MR. BUTLER: No, and what I anticipate, with the guidance of the methodology, would be primarily is a framework. I'll use a number of words here. A framework, you'll have to address the problem in pieces: a regeneration piece, a transport piece, an accumulation piece, the same pieces that are addressed in the Reg. Guide.

You'll have a number of tools that you can use to assess each of those pieces. How you use those tools depend upon your particular situation.

There will be options to take a conservative approach with its incumbent impact on the final analysis or to put more resources into a higher-fidelity approach. So the guidance will provide guidance or options on how you can resolve those individual pieces with some information on what the potential impacts of each approach would be, so that plants could make an informed decision on which was the best approach.

We all know that there's always a quick approach, and I wouldn't call it a "dirty approach," but a very expensive approach just to assume that all the debris is generated; it's all transported to the sump, and install the largest sump you can get away with. I'm not even sure that all plants could get away with that, even if they had unlimited resources, because of just the configuration of their lower containment may not allow as large a sump as they would need under that assumption.

Free area may be large, but contiguous free area in that lower containment is not necessarily a large value.

DR. KRESS: What do you think of this sphere of influence to get the amount of debris in the first place?

MR. BUTLER: Pardon me?

DR. KRESS: This sphere of influence based on the pressure, stagnation pressure, do you think that's sort of the direction you'll take in the NEI?

MR. BUTLER: I imagine so, yes. I mean, as you discussed, there are pros and cons to that approach. The hope is that it can be demonstrated to be conservative.

We already know that in a lot of cases it will not impact the final result because it takes very little debris and very little fiber material and very little particulates to make a difference. So whether or not you assume a large value or half that large value, you still --

DR. KRESS: You've still got to deal with it.

MR. ROSEN: Yes, precisely. So I've already made that recognition, which I believe you just said you have. Is the industry thinking about replacing some of these fiber and particulate insulations with RMI?

MR. BUTLER: We have not advocated that. We have not put that forward as a position that a plant should take, but I think you're correct in that some plants have been making corrective changes in their insulation.

MR. ROSEN: Because there's two ways to go with this problem. One is to build a big sump to take more junk. But if you have already determined you can't build a big enough sump, given all of the stuff you have up in the containment, the next way to do it is to remove some of that and use some other kinds of insulation.

CHAIRMAN WALLIS: It's about the only thing you can do. And if you can't make a bigger sump and you know that the present stuff is going to get there, 50 percent or 70 -- it doesn't make any difference; you've got much more than enough to clog the sump no matter how big you make it, then go do something else.

DR. BANERJEE: How did the BWRs do it? Because they made pretty conservative assumptions, and they seemed to have solved, at least from what we heard --

MR. BUTLER: The BWRs, No. 1, they benefitted from the fact that there is a high degree of similarity of all the BWRs, or at least they are broken down into two generally highly similar types. So they could work on a single solution that could be applied generally by everyone.

In the end, I think it is fair to characterize their solution to be install the largest, most effective strainer that you can get away with, and that allows you some freedom to accept some highly-conservative assumptions and to not be forced to investigate some areas of high uncertainty.

DR. BANERJEE: But what we heard -- now I don't know the details -- was they didn't just install large strainers; they installed clever strainers.

MR. BUTLER: Highly effective.

DR. BANERJEE: Right.

MR. BUTLER: That's what I mean by effective, yes.

DR. BANERJEE: Yes. So that, in fact, you didn't have to put very large strainers, but you did it in a clever way because it had this power of the slow paths and you had the velocity normal instead of tangential, or whatever, going through; I don't know.

But, anyway, the upshot of all this was that they solved the problem in a very effective way, from what I heard. Now is it that you cannot accommodate that amount of strainer in a PWR?

MR. BUTLER: I imagine some plants can. I mean, again, I made the point that the BWRs benefitted from the fact there's a high degree of similarity --

DR. BANERJEE: Right.

MR. BUTLER: -- among all their designs.

What we have to recognize in developing our methodology is some plants will be able to accommodate that as a solution; other plants will find that much more difficult. So we want our guidance to provide enough flexibility or enough options to utilities in how they address the problem.

Some may address it in a design fashion by installing an effective, large sump. Others may address it by trying to reduce their debris generation source, you know, changing their insulation type. Others may try to do it through analysis and showing that they don't transport material to the sump.

CHAIRMAN WALLIS: I think there would be a lot of pressure to do that, and a licensee finds a real box and doesn't have a big sump confidence, strainers at work, if he makes the extreme assumptions, you know, he's going to say, "Let's find some consultant who is going to cut back on all these conservative assumptions and prove that it isn't really so bad."

DR. BANERJEE: Was NEI involved with the BWR solution?

MR. BUTLER: No. That was done under the guidance of the BWR owners' group.

DR. BANERJEE: Because they have many different generations of containment. Each one is completely different from the other.

MR. BUTLER: The degree of differences among the various generations is not as significant --

DR. BANERJEE: I see.

MR. BUTLER: -- as the differences that you would see in PWR containments in terms of the insulation types that are used, the configurations, the volumes, the sump types that are used. There's a very high degree of variability among PWRs.

Well, I think I've addressed a number of these slides.

CHAIRMAN WALLIS: Well, it seems to me it's not just getting all this data. Someone's got to do some really creative engineering analysis to figure out how they make the right predictions. Los Alamos has been working at that for some time. Are you guys going to mount a similar effort?

MR. ROSEN: Not before September 2003.

CHAIRMAN WALLIS: I doubt it, yes, no way. So I was just wondering, has this begun to be a rather superficial thing by September 2003 in terms of technical analysis? I mean, it may point the way to what's out there, but in terms of your own analysis, I don't think you have time to do it.

MR. BUTLER: Well, the guidance methodology is not going to include the CFD analysis that someone would need to calculate transport fractions. That would be part of the implementation because you need plant-specific data. It's a plant-specific resolution item to perform those calculations.

Our methodology would only go to the point of identifying what you would need to look at to address as part of that CFD analysis, guidance on what transport fractions for different materials makes sense, the inputs to that analysis, like the actual plant model needed to calculate results for a particular plant are a plant-specific resolution item and would follow issuance of our methodology.

MR. ROSEN: Let me ask a question of the staff. How long is it, in your -- and maybe it's in the Generic Letter and I haven't understood it -- how long is it before you expect the plants to make either appropriate fixes or be able to show that they're okay with what they have?

DR. WEERAKKODY: As I recall, we don't specify an exact date, but we have specified certain timelines for initial assessments and then evaluations, and then getting enough information.

The reason we don't necessarily like to do that is, as some of you had sometimes thought, the particular plant does the initial assessment and then concludes that they want to jump in and do a fix. They can do that, like Davis-Besse did.

But there may be another plant that determines that they have enough -- that their plant is not susceptible based on the initial assessment, and then it will take them, I think, to collect the data, some of the data they need from the containment, they might do that during an outage. So it might be a couple of years. So the time that it would take to take this issue to a total completion could be very plant-specific.

MR. ROSEN: You have a large tolerance for delay. My fuse is somewhat shorter than yours.

DR. KRESS: Especially with 170 CFD increase.

MR. ROSEN: Yes.

DR. WEERAKKODY: Is that 170 percent or 170 times?

MR. ROSEN: A hundred and seventy times.

DR. WEERAKKODY: Yes, the 170 times core damage frequency, that is a conservative number. If you really thought the core damage frequency of the plant's 170 times higher, this would be an issue that would require something like an audit.

We take that PRA number as an upper bound and take the issue very seriously. Now in terms of the timeframe, we don't have a large tolerance. What I'm trying to get across is each plant, when they get the Generic Letter, they will be required to do an initial assessment. As a result of that initial assessment, it will be their responsibility to conclude whether they are susceptible or not.

If they conclude that they are susceptible with relative certainty, then we would expect them to take relatively quick action because --

MR. ROSEN: So what's relatively quick? I mean, it seems to me if it's not -- it sounds like I didn't miss it in the Generic Issue; it's not in there.

Is there a date that the staff has in mind for when they want to have all the PWRs with this problem behind them?

DR. WEERAKKODY: The furthest date we can anticipate I can't recall off my mind. Even if a plant decides that they are not vulnerable, I think it can then go up to like 2007, but that sort of plan, you know, they have done the evaluation and have concluded that they are not susceptible.

MR. ROSEN: Well, if they're not susceptible, they don't have a problem today. So, I mean, I'm just saying there's two ways to get a way through this problem. One is to prove that you're not susceptible, and I think there will be some plants that can do that. Plants, for example, with very large containments with lots of reflective metal insulation and very little of the other kind, and very big sumps, will probably be able to show that they're okay.

Then there will be plants that couldn't show it no matter what, and they'll have to make a fix, either take out some of the other insulation they have and put in some reflective metal insulation or put in bigger sumps, or both. Those plants will have -- it will take some time, clearly, to do that.

I don't think they'll be able to do that in one outage unless they shut down and stay down for a long time. They'll have to get to work on it. Every bit of that kind of insulation that's not good that they take out during an outage is a good thing, and replace with the reflective metal insulation.

So it seems to me you need to get on with it for the plants that do have a problem. The idea of not having a drop-dead date to me is puzzling.

CHAIRMAN WALLIS: It gets back to this whole Generic Letter being too polite in sort of saying, "Take a look at it and let us know, and then maybe we'll figure out what to do."

MR. ROSEN: If you say you have a problem, it seems like the regulator ought to say, "Okay, we understand it's a probablistic, stochastic process, and it's probable you won't this have problem during 'X' amount of number of years," but we need to say that we're going to limit our liability and our vulnerability by saying everyone won't have this problem by "X" date and having picked that on some basis.

DR. WEERAKKODY: I think if you go to the pages where we discuss specific requests for information or action, we do specify specific due date for each of those. I can't remember the exact date for each of them, but we say, when you receive this letter, you know, by a certain date do this.

MR. ROSEN: Well, I'll study it some more.

CHAIRMAN WALLIS: Well, there's a 90-day response time.

MR. LEITCH: We're at the stage where

we're sort of a plan for a plan rather than actual physical changes.

DR. WEERAKKODY: The Generic Letter does take you through several steps. In fact, what we have done is, if you go to the Generic Letter, page 9, in Item 1 we say, within 90 days of the date of the Generic Letter the licensees are expected to provide certain information.

Then if you go to Item 2, we say, within 90 days of the date of completion of the requested evaluation of the susceptibility that the ECCS basically can function, the plants are required to provide us information.

CHAIRMAN WALLIS: I think they're going to be in a real bind to do it in these two 90-day periods.

MR. ROSEN: But even so, if they could do it, then that's 180 days, and then you get to 2(b), as in "bravo." It says, "if any plant modifications are identified as being necessary to assure compliance with regulations, that other regulatory requirements will not be implemented until a future scheduled outage described in the interim compensatory measures."

DR. WEERAKKODY: Okay.

MR. ROSEN: It sounds to me like you might put them all in during the next outage. Is that the implication?

DR. WEERAKKODY: No, I think what we are doing here is, you know, there may be plants out there, when they look at this information, they might be looking at information and the analysis they need to do within the first 90 days, and conclude that their ECCS is degraded but operable, and within the regulation that takes them to the instructions that we give them under Generic Letter 91-18. So they would be required to take interim compensatory measures while they are taking care of the issue.

MR. ROSEN: They absolutely should do that now. But it seems that 2 "bravo" or the next one, 2(c), ought to say something like, "All required modifications should be complete by" -- and you pick a date and say, "or provide justification for not meeting that date."

MR. LEHNING: Kind of the problem with that is, like when you request an action, you have to have a regulatory basis for doing that, a cost/benefit, but at the time we're asking someone to do that, but say if a licensee is just barely out of compliance, they have just this one piece of insulation, and if they have just one break, it's a real low probability. So we can't tell them, you know, we don't have a basis to say, "You need to do it right away." If a plant has a really bad configuration --

MR. ROSEN: I didn't say right away. I said pick a date.

MR. LEHNING: Or even to pick a date, we can't say you have --

MR. ROSEN: I didn't say right away. Don't overreact. What I said is, pick a date, a date certain, which we then could say, okay, now we can calculate the vulnerability of the fleet, assuming everybody waited that long. Otherwise, it's not bounded.

CHAIRMAN WALLIS: Let's see, this draft has not been given to NEI, this Draft Generic Letter? So they don't know what we're talking about?

DR. WEERAKKODY: Dr. Rosen, what we can do is we will think about your comment and some of the reasons --

CHAIRMAN WALLIS: I think what is going to happen is, if you extend this out even without the tightness that my colleague wants you to add to it, that it may well be that the industry is going to come back and say, "We can't do it." They'll scream, you know, this is an unreasonable thing.

They'll have comments on the letter, and then you'll have to fight them, if you believe what Los Alamos has been telling us about this being a real problem with all this debris, and it only takes a bucketful of fibers to plug a screen, and so on.

MR. ROSEN: Well, I'm not arguing for precipitous action. What I'm arguing for is definitive -- a definitive timeframe, a definitive framework that everyone knows about.

CHAIRMAN WALLIS: Well, I don't think that your NEI guidance is going to be available in time, it's going to be deep enough technically to satisfy the NRC the way that they're going. So this Generic Letter is going to go out, and then the licensees are going to be asked to do something, and they won't know how to do it. The only thing they can do is adopt the Los Alamos approach.

MR. ROSEN: But, Mr. Chairman, we have got to decide what we're going to say to the full Committee.

CHAIRMAN WALLIS: And it's going to be interesting.

MR. ROSEN: And maybe we should allow Mr.

Butler --

CHAIRMAN WALLIS: Yes, I think we should let Mr. Butler -- we're sort of talking among ourselves. Maybe we should let you finish your presentation, and then we will decide.

I thought you would come up here more sort of saying how the industry will respond to the kind of thing that they're going to be asked to do, and whether or not they can manage to do it.

MR. BUTLER: We'd be glad to do that after we have seen it.

CHAIRMAN WALLIS: See, you can't do that until you've seen it, right?

MR. ROSEN: And I'm complaining about what I see as not being definitive enough.

MR. ARCHITZEL: I think I would like to make a comment that, you know, this is really still considered an industry initiative, and we're responding to that initiative.

CHAIRMAN WALLIS: Well, it's an industry --

MR. ARCHITZEL: That's the premise behind that Generic Letter. There is an industry initiative that we presume is going to be acceptable. If that premise isn't good, it's still industry's action and it's their responsibility to --

CHAIRMAN WALLIS: Yes, but your Reg. Guide is very specific about what it wants done.

MR. ROSEN: Well, it may be an industry initiative, but it is a regulatory matter, and it isn't up to the industry what the staff of the Commission does. Industry's participation and cooperation has been good. That's wonderful. But at some point I'm arguing that -- and I'm speaking to the staff and to my colleagues -- that this has gone on long enough without a date certain.

CHAIRMAN WALLIS: Well, there are two 90-day stages here, which even then they're going to put a lot of pressure on industry.

MR. ROSEN: For analysis, yes. Collecting data and analysis, but --

CHAIRMAN WALLIS: And having a plan of what they're going to do.

MR. ROSEN: And then all I'm asking for is them doing it. You know, if you put a date certain on the end of it, all the other things have to start backing up, and pretty soon you're able to decide whether you can use those other dates in any reasonable way. It may be just what you say, but if you put a date certain on it --

CHAIRMAN WALLIS: Well, NEI must be pretty close to the pulse of industry. I mean, they've got a letter saying they've got to come up with -- 90 days/90 days, that's not very long. It's half a year. By that time, they're going to know what they're going to do to fix the problem? Do you think that's a realistic thing to ask industry to do?

MR. BUTLER: If you're asking me what would be the best time to issue the Generic Letter and start that 90-day clock, it would be when we have the methodology and have agreement with the staff on that methodology.

CHAIRMAN WALLIS: Well, I don't see -- you've shown us no methodology. So I don't have any faith in you having it in half a year either.

MR. LEHNING: Mr. Chairman, may I make a comment? I think there's just some misunderstanding about the two 90-day periods. The first 90 days is the 90 days after the receipt of the letter, and then the second 90 days would be --

CHAIRMAN WALLIS: Yes, but you're not going to send the letter out, you see. You're going to wait and wait and wait and wait.

MR. LEHNING: It would be 90 days after the licensee completed the evaluation, not 90 days after the first submittal --

CHAIRMAN WALLIS: So when is this letter going to go out realistically?

MR. LEHNING: The schedule? I think it's planned for the summer.

CHAIRMAN WALLIS: So it's pretty soon?

MR. LEHNING: For the final, for the final version of the Generic Letter. The draft is planned I think in March or April, yes, for the draft, for public comment.

MR. DORMAN: The clarification that needs to be made here is that the first 90-day period is measured from the issuance of the Generic Letter. At that time the licensee provides a plan, and that plan includes when they propose to complete their analysis. Then the staff has an opportunity to determine whether that timeframe is appropriate and acceptable.

CHAIRMAN WALLIS: But if they don't have the NEI guidance or analysis, how are they going to plan to complete their analysis?

MR. DORMAN: That would, obviously, impact them. But the second 90 days, then, doesn't start from their first response. The second 90 days start from completion of the analysis in accordance with whatever plan they presented after 90 days. So the second 90-day report is not 180 days after the Generic Letter. It's probably something longer than that.

CHAIRMAN WALLIS: I just thought, my intuition is it will take NEI years. You're asking for days. It isn't compatible. Maybe I'm wrong. Maybe you guys are really ready to issue a guidance and everything's worked out.

MR. BUTLER: My concern really comes at it from a different point of view. I mean, I agree that there is uncertainty with the September date. I mean you just have to accept that with any kind of effort that addresses this many issues, as many issues as this one does.

But my concern would come from a postulated schedule where a Generic Letter comes out in final form, starts a 90-day clock. Every PWR utility then looks at it and says, "I've got to have this methodology right now to begin my evaluation." That then puts a high degree of pressure to complete that very quickly and get it out to industry, and during a time when discussions are probably at a critical stage with NRC staff, you're trying to complete everything.

We would basically be forced to try to complete the methodology with too many cooks in the kitchen, and that will cause some problems in itself. That's one of my main concerns.

CHAIRMAN WALLIS: Well, I'm concerned about your having any cook. I think you're going to have a Task Force which is thinking about it and talking about it, and you don't have any cooks cooking in the kitchen at all.

A cook is going to actually produce this guidance. You know, here's some analytical method; it's based on fundamentals and data and engineering, and so on and so on, and here's the justification for it.

MR. BUTLER: Oh, we do have --

CHAIRMAN WALLIS: Do you have all that stuff?

MR. BUTLER: The primary contractor on the methodology is Westinghouse.

CHAIRMAN WALLIS: And they have this methodology there? They just have to unveil it?

MR. BUTLER: We are working on it. I mean, we are working on it. We've got a fair, a high degree of completion on the regeneration portion of it, looked at drafts of other portions, of debris transport and the different phases.

CHAIRMAN WALLIS: So if we advise the

staff to go ahead, send this out, and as fast as they can implement it, you guys can respond?

MR. BUTLER: As far as issuing it for draft, a draft for comment, once it's issued for a draft to comment, one of the comments we'll provide is on the schedule and some of the concerns of how that schedule can impact or interplay with the guidance development, some of the same concerns you've expressed.

CHAIRMAN WALLIS: Well, without seeing anything from Westinghouse, there's no way I can assess this guidance that you have as a hope.

DR. WEERAKKODY: I do want to make one comment. Hopefully, at least partly, this is Dr. Rosen's question or concern.

One of the things we have, or we are trying to accomplish with the Generic Letter, is within the 90 days, before the licensees do a full-blown evaluation, ask them to either put interim, compensatory measures in place that could reduce this aspect of it significantly.

In fact, the Generic Letter, we do identify some of the known interim, compensatory measures for this activity in the Generic Letter itself.

MR. ROSEN: I understand you're going to ask them for interim, compensatory measures. My problem with them is that, while I am sure the utilities can do that and define them and write procedures, operating procedures, and train operating crews to, in fact, implement those interim, compensatory measures, given the phenomenology we've heard about today, I'm not sure that they'll work. I'm not sure they'll be effective, interim, compensatory measures.

CHAIRMAN WALLIS: Well, I think this is very interesting. I think we're setting a stage for quite a drama.

(Laughter.)

MR. ROSEN: We're talking about a low-probability event.

CHAIRMAN WALLIS: Yes, maybe it will go away.

MR. ROSEN: But, still, we have to assess, under this very stressful phenomenology, that operators take these extraordinary interim, compensatory measures, including shutting off recirculation, or whatever those measures are, things that are counterintuitive to them.

But even if they did them, would that let

-- I presume that's to let all the particulates and filterable materials settle out, and then they can start it up again. But would that really de-suspend them or not? I'm not sure that I've been shown data that shows that that would be effective.

DR. KRESS: I thought the pool CFD velocity possibly showed that they would settle out in the sump, but they would make it to the filter anyway, even if you cut them off and them wipe them and suspend, and turn it back on. So I don't think that's a compensatory measure that would be acceptable.

DR. BANERJEE: How many plants are at sort of risk compared to -- and cannot apply a filter solution like the BWR solution? Because that, we know the area of the filters. So how many plants have low areas or how many plants are at risk? If we can do this assessment fairly rapidly -- the Los Alamos people probably already did it. How many are we talking about?

DR. WEERAKKODY: I know some of the information that was published in the Los Alamos report. I think we may be mixing up the risk aspect of this analysis, the concept of the risk analysis, with the establishment of the credible concern here.

What the Los Alamos study showed was that this is a credible concern, and in the process they did the risk assessment with some considered assumptions and showed that the core damage frequency could go up by a very significant factor.

I think the part where Los Alamos concluded that this is a credible concern is mainly based on deterministic. In other words, we did not factor in the probability of the breaks. We did not factor in the probability of different events happening or not. We just concluded that, based on all the information, this can happen.

DR. BANERJEE: Yes, but it's not a very huge thing. We are talking of plants which have insulation with particulate matter in it because we were told fiber is always there, and then it's filter area per megawatt after that, more or less.

If that can give you then which plants, you can change the filter to a BWR-type filter and which ones have to do something different. Right? I mean it's not a huge problem. I mean it may be a huge problem for the plants that cannot do it, but there must be just a handful of these.

CHAIRMAN WALLIS: I think we'll get this perspective. If these things go out, this perspective will have to be developed, won't it?

DR. BANERJEE: Right. So you're saying let it happen?

CHAIRMAN WALLIS: Well, we have Mr. Butler here still, and we've got ourselves talking among ourselves. But do you have any wisdom for us on these matters?

MR. BUTLER: Just key points to not forget: There is no single answer to this. Because of the high degree of variability of all the PWRs, there are, in effect, 63 different answers to the problem. There is a whole range of sizes and PWR sumps, and you could probably identify 10 plants that have the smaller sumps, but those also may be the 10 plants that have a low probability of debris transport or a high degree of RMI.

You know, there aren't plants that stand out because of the worst circumstances in all relevant aspects; there is just a high degree of variability. Because of that, we need to provide the plants with the tools and the options and the time for them to address it in the most appropriate fashion for their plants.

CHAIRMAN WALLIS: Well, I was sitting here listening to Los Alamos. I don't see, from what they presented, which was very interesting and had an awful lot of things, I don't see a clear path which says, knowing what they have told me, I can see the way to developing guidance for a plant. Maybe you guys are much smarter.

Knowing all the stuff they presented today, if you're going to consider all that stuff, I can't see my way through the thicket to say, "This is the way I would develop a guidance for a plant." I would probably have to fall back on something conservative.

MR. BUTLER: And in some areas we will likely have to do that.

CHAIRMAN WALLIS: And it might be very conservative.

MR. BUTLER: Well, we're trying to address some of the major conservatisms as part of our guidance upfront in discussions with staff. You are already aware of some of those discussions in the LBB area. We think the current GDC-4 regulation allows us to exclude the regeneration for LBB-qualified --

CHAIRMAN WALLIS: Do you want an opinion of this Committee on the LBB issue? It hasn't been brought up today.

MR. BUTLER: I wasn't going to bring it up in my discussion. I'm not sure I want to ask the question if I'm not willing to live with the answer, but I'll leave it to you to express your opinion or not.

MR. ROSEN: Well, I would like to come back to this date thing. I think I've read this more carefully, and I think it actually is in there, but I want to verify that with you and the staff, not you, John, because you haven't got it in front of you.

But the staff says there are two 90-day periods, and the second 90-day period, it says, "Within 90 days of the date of completion of the requested evaluation of the susceptibility, provide the following: a description of the actions taken," et cetera, et cetera.

Then it goes on to "a general description of an expected implementation schedule for any plant modifications that are necessary to ensure the availability of the ECCS and CSS recirculation functions under the postulated debris loadings. If required modifications will not have been completed by the end of the subsequent refueling outage, provide justification."

So that, very simply to me, adds two 90-day periods -- that's a half a year, 180 days, half a year -- plus a typical refueling outage schedule or refueling cycle, like another 18 months.

MR. LEITCH: The two 90-day periods are not back to back necessarily.

MR. ROSEN: They're not back to back. Even if they were --

MR. LEITCH: The second 90-day clock can start a year after the end of the first one.

MR. ROSEN: But even if they were -- let's just say that's the minimum --

MR. LEITCH: Yes, right.

MR. ROSEN: The minimum would be a half a year plus a year and a half. So that's two years. That's the minimum but not the maximum. So I think my question stands.

MR. LEITCH: Yes.

CHAIRMAN WALLIS: Why are they not back to back?

MR. DORMAN: Because the first one requests a schedule --

CHAIRMAN WALLIS: Yes.

MR. DORMAN: -- for their evaluation, and then they do the evaluation. When they complete the evaluation, the second 90-day clock starts.

MR. LEITCH: They haven't prescribed the time to do the evaluation.

MR. DORMAN: So it allows for the licensee to propose a time period for the evaluation. Obviously, if they came in with five years -- maybe that's a hard part over that.

CHAIRMAN WALLIS: Okay. So you've got April 1st, 2004. It can also be within 90 days of the completion of the containment surveillance, or am I --

MR. ROSEN: Whichever is later.

CHAIRMAN WALLIS: Yes, whichever is later. Well, okay.

So what happens? These things go out for public comment? Is that the way it goes?

DR. WEERAKKODY: Yes.

CHAIRMAN WALLIS: Now how long does that take? Sixty days? Then by then you get the comments, and then you make a decision in how long?

MR. LEHNING: The final issuance?

CHAIRMAN WALLIS: Yes.

MR. LEHNING: Is that what you're asking, what the final issuance? It is planned for, I think, the fall.

MR. ARCHITZEL: I've got a schedule here. Particular dates, we've got it laid out.

So the question is, when does the final Generic Letter go out?

CHAIRMAN WALLIS: Yes.

MR. ARCHITZEL: Okay, the final, it's currently scheduled for August.

MR. DORMAN: Yes, and for the regulatory guidance, it's scheduled for September.

CHAIRMAN WALLIS: Yes, okay.

MR. ARCHITZEL: But, remember, this hasn't been through the CRGR yet, and so the process could slip.

MR. ROSEN: You may be asking too hard a question for the ACRS. The ACRS is trying to figure out how you're managing this, and we don't --

CHAIRMAN WALLIS: That's right. I think there's so many imponderables about whether CRGR is going to approve it or how much slack you get from industry, and all that, that I think the only thing that we can really do at this stage is to go into a sort of caucus now and say, "Go ahead, issue these things for public comment."

MR. ROSEN: Well, we can do that for sure.

CHAIRMAN WALLIS: It's too early for us to get involved in the melee here.

MR. ROSEN: Right, but we can certainly express our angst about not having a schedule with an end date, if that's the will of the Subcommittee and the full Committee.

CHAIRMAN WALLIS: I guess we could write a Larkinsgram, and then we could put in a sentence or two about needing an end date or something.

See, if we want the Committee to write a letter, then we're going to have to ask these folks to come before the Committee in two days, and we're going to have to schedule it and squeeze it into a schedule which is already full.

MR. ROSEN: Well, aren't they supposed to? It's already scheduled?

CHAIRMAN WALLIS: But it's a short thing. It's only 15 minutes or something.

MR. SNODDERLY: No, no, no. Right now there's an hour and a half scheduled.

CHAIRMAN WALLIS: Oh, it's an hour and a half scheduled?

MR. SNODDERLY: Excuse me. This is Mike Snodderly.

Right now there is an hour and a half scheduled from 10:30 to 12:00 on Thursday.

CHAIRMAN WALLIS: But if it were a Larkinsgram, it would simply be a discussion with this Committee, maybe half an hour with the full Committee, saying that there are things that we have learned today and we just will share it with our colleagues, but it wouldn't be that this would go into a letter where they would they have to make their own decisions.

MR. ROSEN: But, typically, Larkinsgrams were used to go out and to say, you know, it's okay to release it for public comment. But I have a more substantive concern, which is that this is, I think, an important problem potentially in some plants, and that there seems to be no clear resolution date at least proposed in the Generic Letter.

DR. KRESS: I share that concern, and that would take a Committee letter?

MR. ROSEN: Right.

CHAIRMAN WALLIS: It would take a Committee letter? You can't put that in a Larkinsgram because the whole Committee has to --

DR. KRESS: We normally don't put that substantial of comment --

CHAIRMAN WALLIS: All right, so the whole Committee would have to confront the issues, and they would have to have a presentation?

DR. KRESS: I think so.

CHAIRMAN WALLIS: And they would have to come up-to-speed. So they would have to have a shorter version of what we heard today.

DR. KRESS: Now be aware that any members that aren't here, at least two of them that sit over here are well up on this issue and went through the BWR part of it, and are quite aware of the problems and the ramifications. So it's not like they need extensive educating.

CHAIRMAN WALLIS: Well, I think the staff already knows this Subcommittee is concerned about this business of dates, and so on. Do we need to have the authority of the whole Committee invoked?

MR. SNODDERLY: Graham, if I can make a suggestion, I would like to say that this could be discussed at the P&P tomorrow, and in the meantime we ask the staff to prepare a presentation for the full Committee and we would get back to them before Thursday.

But, as of right now, we would prepare, have them condense their presentation for an hour and a half on Thursday from 10:30 to 12:00, with emphasis on the schedule of the Generic Letter, what is requested, and when they think that would be anticipated.

MR. ROSEN: When they think that would lead to fixes in the plants that need it?

MR. SNODDERLY: Right, and whether there would be a final date or not, and also to reflect, I guess, on page 7, because it seems to be very contingent upon NEI developing this subsequent guidance by September 2003. Because when you send in your 90-day letter to say what kind of an evaluation, you might say, well, I'm going to do it in accordance with the methodology being developed by NEI. So if that goes beyond --

MR. ROSEN: Almost certainly every plant will do that.

MR. SNODDERLY: Right, right. So that seems to be a key.

CHAIRMAN WALLIS: Well, I have very little in there being a methodology.

MR. SNODDERLY: Right. So that would go with your concern and Dr. Kress' that this does appear, and Dr. Rosen, that there isn't this end-all date or a closeout date.

And then you could decide at the P&P whether you want to discuss that --

CHAIRMAN WALLIS: That's why I think that before we go to the P&P, I think this Subcommittee has to decide what they want and tell the P&P that's what they advise them to do.

MR. ROSEN: But two members of the P&P are here.

CHAIRMAN WALLIS: But, you see, my inclination was to say there's enough here; it's going to stir up enough stuff that you could send out a rough direct letter and the Reg. Guide, and there may be a few details like discussed here to be fixed up, but that can be fixed up when the public comments come back. Send this out, and that's going to start the ball rolling.

It's going to put NEI on the spot. It's going to put some of the licensees on the spot, and it's going to put LANL on the spot to be more specific about what they're recommending to the staff. Then things will happen.

MR. ROSEN: Well, I think what we're talking about is a procedural question, which I think maybe we could get some help from the staff.

CHAIRMAN WALLIS: What I was hoping --

MR. ROSEN: Can we put that put that much into the Larkinsgram?

CHAIRMAN WALLIS: Well, what I was thinking, that we simply have a Larkinsgram saying we have no objection to these going out for public comment. They will then go out for public comment.

That's all we need to say. Everything else will take its course. It has to. It just follows on from --

MR. ROSEN: Not if we don't say something about the schedule.

CHAIRMAN WALLIS: We'll see it again. It comes back from --

MR. ROSEN: No, no, I'm saying, not unless we put a burr under the saddle. I mean, it will continue to do what it's been doing, which is moving ahead like an iceberg.

CHAIRMAN WALLIS: I thought these 90 days were not moving ahead at a snail's pace, but maybe I'm under some illusion.

MR. LEITCH: I have no problem with recommending that we send it out for public comment in its present form. I think that it addresses one refueling outage or no later than whatever it says, one fuel cycle. I think that's a reasonable approach to send it out for public comment that way.

You know, there may be some changes in that as a result of the comments, but I think that's a reasonable approach. I am frustrated that it's taken this long to get to this point, but that's behind us now. I mean we can't recoup that time.

I mean, I think this whole issue is an

issue where striving -- what's the saying? Perfection is the enemy of good enough. I think we've killed this thing trying to analyze it. I think we've got some plants out there that we know are much more susceptible to this than other plants, and we just ought to get on with it and get those plants fixed.

But we've taken an awful lot of time with this, and we can't do anything to recoup that time at this point. There may be some lessons learned from how long this has taken, but what I'm saying is I think now the thing to do is, without further delay, get the Generic Letter out for public comments or, yes, get the thing out for public comments.

CHAIRMAN WALLIS: And the Reg. Guide.

MR. LEITCH: The Reg. Guide, yes.

DR. KRESS: Well, yes, and I agree pretty much with what you said, but I see it as somewhat analogous to the control rod drive cracking issue. Some plants are a lot more vulnerable than others. So that when the NRC went out with the Generic Letter on this issue, they gave those that were less vulnerable more time, and those that were very vulnerable, they said, hey, you had better get on with it here, and especially these, these, these.

Now I think the Generic Letter I see gives all plants equal time to assess their vulnerability and make a plan and go on. But I think that there's a missing ingredient, and that is how vulnerable are they; how urgent does it have to be when they're vulnerable, and can we give the ones that aren't vulnerable more time?

CHAIRMAN WALLIS: I don't think it helps. If they're not vulnerable, they just come back with a short answer: We're not vulnerable.

DR. KRESS: Yes, well --

CHAIRMAN WALLIS: There's no reason to get into all the topics.

DR. KRESS: I think there are gradations of not vulnerable.

CHAIRMAN WALLIS: But that's information, though. I think the NRC needs to know how vulnerable they are.

DR. KRESS: Yes.

CHAIRMAN WALLIS: They don't know it until they've got these answers.

DR. KRESS: Yes, once you find some that's very vulnerable, I think you need the answers faster and you can do something better with those. But I guess I'm coming down on the side of just going ahead and saying: Issue these Generic Letters, the drafts, and the Reg. Guide, and then let's worry about this other part when the answer is due in on vulnerable.

CHAIRMAN WALLIS: Do we need their presentation before the full Committee by the staff?

DR. KRESS: No, not if we just write that Larkinsgram.

MR. ROSEN: Well, here's what I would like to have them talk about at the full Committee: Focus on very basic phenomenology without getting into too much of it, and then get into the schedule and assure the full Committee, and me, that this will move forward, given whatever it is you say in the Draft Generic Letter.

Is that all right with the staff?

CHAIRMAN WALLIS: What do the other members of the Subcommittee have to offer for advice?

DR. FORD: Well, I agree with the issuance of the Generic Letter for public comment now, and that's the essence of the Larkinsgram. Where we're sticking is, do we put in this question of the timing?

As you know, I get very impatient when things drag on. So, inherently, I'm behind Steve on this one. Whether that needs to have a full meeting, I'm not at all sure.

MR. ROSEN: Well, it's on the schedule

already.

CHAIRMAN WALLIS: When does this come back to the ACRS? Doesn't it come back? When does it come back? Are you going to bring it back to us after the public comments and before you issue these things?

MR. ARCHITZEL: Well, the Generic Letter would not necessarily come back if there weren't significant public -- certainly, if you want it, it will come back. We were planning to come back when the guidance was evaluated by us and we were accepting it or had the significant differences in it. So that's really the next time when I thought we would come back, is when the guidance is in place.

CHAIRMAN WALLIS: You haven't really had comments on the Guide.

MR. ARCHITZEL: We don't have the guidance yet.

MR. DORMAN: We're expecting to --

CHAIRMAN WALLIS: The Guide, the Reg. Guide.

MR. DORMAN: We're expecting to come back in July to talk about the public comments on the Reg. Guide and how we expect to resolve those. That's to support the September issuance.

CHAIRMAN WALLIS: I think that that would be appropriate for us to ask at that time what happened with the Generic Letter. They sort of go together, don't they? I think you would probably want to come back with both. So we get another crack at you, and you know our concern with timeliness.

MR. DORMAN: Uh-hum.

CHAIRMAN WALLIS: We've got the majority of the Committee.

(Laughter.)

DR. KRESS: Three members missing, I think.

CHAIRMAN WALLIS: Yes.

MR. ROSEN: Five members missing, two of which know of this issue in detail.

CHAIRMAN WALLIS: I'm bothered about the ACRS writing a letter on what's after all a draft before we see the evidence. I wanted to stir up these replies from industry, so we can see what's going on, and then we can come to them with advice. At the moment it is more: Send it out, find out more about the problem, and get on with it. That's what we're asking for.

MR. ROSEN: I could live with that.

CHAIRMAN WALLIS: So we'll make a Subcommittee report? We won't ask the staff to come back to the full Committee? Or do you want the staff to come back to the full Committee?

MR. ROSEN: I think the staff should come back and talk about the Generic Draft, Generic Letter, and the schedule that it requires.

CHAIRMAN WALLIS: So then we could put it to our colleagues, would you like a Larkinsgram or --

MR. ROSEN: Or at that point we could say we suggest a Larkinsgram, but we're concerned about the schedule. We want to get on with it.

CHAIRMAN WALLIS: That's okay, too.

DR. FORD: Do I understand that the sticking point is, if it is a Larkinsgram, we cannot put in the question of scheduling, our concern about scheduling?

CHAIRMAN WALLIS: We can't add that in as a sentence?

DR. FORD: That's what I'm understanding.

DR. KRESS: I think that level of comment could probably go into a Larkinsgram.

CHAIRMAN WALLIS: Yes, why not? But then it does have to come to full Committee. If there's going to be a comment, it probably has to come before the full Committee. But I don't think we need an hour and a half. You guys can do, put the essence of it out in half an hour, and we won't go into the LANL stuff.

DR. KRESS: John's agreeing that we could do it, because it has to be voted on by the full Committee, but --

CHAIRMAN WALLIS: So we could put it in a Larkinsgram saying it will go out for public comment --

DR. KRESS: Yes.

CHAIRMAN WALLIS: -- and then say that there should be consideration about the schedule.

DR. KRESS: Yes, it's only appropriate for the full Committee to vote on it if they've heard the details of what our concern is.

CHAIRMAN WALLIS: Yes.

DR. KRESS: So we'll have to have enough for that.

MR. ROSEN: That's why I asked the staff to talk about the schedule. It's in the draft --

DR. FORD: I think Tom brought up a good analogy to the VHP situation. The degree of urgency is dependent on some sort of assessment of risk.

MR. ROSEN: Sure, and we don't know what that is.

DR. FORD: And we don't know what that is, but that, presumably, from what I'm hearing from LANL's staff coming out with, is saying that they're moving towards that assessment of risk.

CHAIRMAN WALLIS: Well, maybe it's going to be conditional, that when they get this information from the first 90 days, then they can decide if there isn't a need to move faster on the plants that have problems.

DR. FORD: Yes.

MR. ROSEN: And I think we should take the conservative position that it is likely, that it is possible that we will get some reports that say it's a problem, and that, therefore, it will then be seen to have been appropriate to have pushed to get on with it.

CHAIRMAN WALLIS: We talked about the letter. So we're asking the staff to come before the full Committee and discuss the letter, just the letter.

Do we want them to come and discuss this Reg. Draft Guide?

MR. ROSEN: I don't want them to.

CHAIRMAN WALLIS: Well, I think that it might be at least a couple of minutes because it is fairly -- I don't think you should go into details, but I think you need to point out that there is a Draft Reg. Guide, that it does ask for all the specific things. You might just have one slide that says what are those specific things. It's got to be the sources of debris and debris transport, the effect on -- they could analyze those things, and so on.

MR. DORMAN: It gives context to the --

CHAIRMAN WALLIS: You could summarize the Reg. Guide in one slide?

MR. DORMAN: Yes, it gives context for what we're asking for in the Generic Letter.

CHAIRMAN WALLIS: Because the two go out together. Without the Reg. Guide, how can you send this out?

DR. WEERAKKODY: I have a question. When we come in front of the full Committee to talk about the Generic Letter, we probably would need at least a few more slides to do the context unless each member who is not here is already familiar with the issue. I would assume that's the case.

CHAIRMAN WALLIS: We don't need too much history.

DR. WEERAKKODY: Not too much, just we'll focus on the letter, but have a few --

CHAIRMAN WALLIS: Well, they're all

familiar with this to some degree.

DR. KRESS: At least four out of the five are very familiar with this issue.

CHAIRMAN WALLIS: Well, there are six of us here. So there are five more --

DR. KRESS: Five missing, yes.

CHAIRMAN WALLIS: Now NEI wants to come again?

MR. BUTLER: To the full Committee meeting?

CHAIRMAN WALLIS: Yes.

MR. BUTLER: It won't be me. I'll be in San Diego. If you need somebody --

CHAIRMAN WALLIS: I think if NEI comes, what I will be interested in is really, how is industry going to take this and what's going to be the effect? Are they going to be able to do it? They don't know what is in it yet. So, okay, so you can't really comment on something you haven't seen, no. So you don't need to come back.

MR. SNODDERLY: I think we would also need some clarification about future ACRS interactions because I thought I heard Gary Holahan had said this morning that the opportunities for future ACRS review would be when the Generic Letter was final and also when the Reg. Guide, the associated Reg. Guide, was final.

So I think we would want to know, and then I thought I heard Ralph say that we would not necessarily see the Generic Letter again.

MR. ARCHITZEL: Mike, I would clarify that. You always get to see the -- you make a choice. The ACRS makes a choice on it. We distill the comments and provide them because we met on the Generic Letter. When the comments come in, we can meet again.

The point is, this issue, you have to meet on again no matter what. You have to agree on the issue, the generic safety issue, and it could be at the Generic Letter stage.

CHAIRMAN WALLIS: We have to sign off on something, do we?

MR. ARCHITZEL: On the generic safety issue, you have to meet on that, yes.

CHAIRMAN WALLIS: But if there's no change from this draft, no significant change from these documents, I think it could be a very short meeting.

MR. ARCHITZEL: Exactly.

MR. SNODDERLY: Or waive the meeting. We have to come back to you, no matter what, to get a waiver in that meeting.

CHAIRMAN WALLIS: Are you expecting a storm of comments back from industry or are they just going to say, "This is fine," we go out and do it? Have you tested the waters?

MR. ARCHITZEL: No, I think we'll get the comments on the leak-before-break and things like that, but not a storm of comments, no, just the schedule comments.

CHAIRMAN WALLIS: You haven't asked any guidance on the leak-before-breaks.

MR. ARCHITZEL: Well, we've already got a letter that the staff considers regarding a decision --

CHAIRMAN WALLIS: You've already made a decision.

MR. ARCHITZEL: That's our current position.

CHAIRMAN WALLIS: It's the end of this meeting. So I can adjourn? Is that the appropriate word?

MR. SNODDERLY: I think, Graham, yes, and at the beginning of the meeting we had to make two decisions. The first was decide on the need for presentations by the staff at the February 6th date.

CHAIRMAN WALLIS: And we decided, yes, they would do it.

MR. SNODDERLY: And we've decided that they will present from 10:30 until 12:00.

CHAIRMAN WALLIS: About the letter with this or the summary slide on the Reg. Guide.

MR. SNODDERLY: Okay, and then our recommendation to the full Committee would be whether the Draft Generic Letter and associated Draft Reg. Guide can be issued for public comment. Then we would have a Larkinsgram.

CHAIRMAN WALLIS: There may be a further sentence about schedules. That's probably the way it is headed.

MR. SNODDERLY: Okay.

CHAIRMAN WALLIS: There may be members of the Committee who want to write a long letter.

MR. SNODDERLY: Then I think we can adjourn.

CHAIRMAN WALLIS: All right, so we're ready to adjourn. Any objection?

(No response.)

We're adjourned.

(Whereupon, the foregoing matter adjourned at 6:12 p.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards Thermal-Hydraulic Phenomena Subcommittee

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Davis

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

United States Nuclear Regulatory Commission

GSI-191
"ASSESSMENT OF DEBRIS ACCUMULATION ON PWR SUMP PERFORMANCE"

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Director Division of Systems Safety and Analysis
February 4, 2003

United States Nuclear Regulatory Commission

GSI-191 Presentation

- RES Study Concluded that PWR Sump Concerns were Credible but Need to be Addressed on Plant Specific Basis
  - More and finer debris could be generated by a HELB
  - Sump clogging due to more and finer debris
- ACRS Involvement requested
  - MD 6.4 role to Advise the Staff on the processes and methodologies for addressing Generic Safety Issues
  - OL 701 Role to Review selected CRGR Generic Communication packages before Public Comment Stage

United States Nuclear Regulatory Commission

GSI-191 Presentation

- Justification for Interim Operation
  - Low probability of LOCA requiring recirculation
  - Higher frequency LOCAs more time to or no recirculation, less debris, operator recovery potential
  - Likelihood qualified piping will leak before break
  - Margins in NPSH available, uncredited containment overpressure, cavitation operation potential
  - PWR containment/sump compartmentalized configuration
  - Ongoing industry actions to improve sumps and increase containment cleanliness
  - Ongoing configuration assessment walkdowns

United States Nuclear Regulatory Commission

Resolution Process for GSI-191

- Activities include
  - Revise Regulatory Guide 1 82
  - PWR Industry Initiative to Develop Guidance for Plant Specific Evaluation
  - Generic Letter
- Plant specific assessment needed to assure the reliability of ECCS in recirculation
- PWR industry to develop guidance acceptable to NRC to evaluate configurations
- Oversee evaluations of recirculation adequacy
  - Review generic letter responses
  - Sample audits of evaluations
  - Temporary instruction to allow inspection oversight of activities

United States Nuclear Regulatory Commission

STATUS AND PROPOSED RESOLUTION OF GSI-191 "ASSESSMENT OF DEBRIS ACCUMULATION ON PWR SUMP PERFORMANCE"

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Division of Systems Safety and Analysis
Plant Systems Branch
February 4, 2003

United States Nuclear Regulatory Commission

OVERVIEW

- Generic Safety Issue (GSI) - 191
- Generic Issue Program Stages
- Technical Assessment
- Regulations and Guidance Development
  - Generic Letter –John Lehning
  - RG 1.82 Rev 3 – B. P. Jain
  - Industry Evaluation Guidelines John Butler
- LANL Support Activities
- Industry Meetings/Initiatives
- Current Plans and Schedules
- GSI-191 Resolution/Closure

United States Nuclear Regulatory Commission

Generic Safety Issue GSI -191

- 10 CFR 50.46 (b)(5) and Appendix A to 10 CFR 50, Criterion 35 Require Long Term Emergency Core Cooling
- Debris Blockage of Sump Screens may Prevent the Injection of Water into the Reactor Core or Containment Spray
- USI A-43 Examined Emergency Sump Performance
  - closed in 1985 (Generic Letter 85-22; Reg Guide 1.82 Rev. 1)
- GSI -191 Re-Assesses Effect of Debris Accumulation on PWR Sump Performance due to
  - Events at BWRs
  - New information identified since USI A-43 closure, including BWR resolution

United States Nuclear Regulatory Commission

Generic Issue Program Stages

(Management Directive 6.4)

1 Issue Identification

2 Initial Screening

3 Technical Assessment

4 Regulation and Guidance Development (Development of GL and RG DG -1107)

5 Regulation and Guidance Issuance

6 Implementation

7 Verification

United States Nuclear Regulatory Commission

Technical Assessment (Stage 3)

- Parametric evaluation to determine if loss of ECCS NPSH margin due to sump clogging was a credible concern.
  - Modeled plant specific parameters based on NEI survey information (e.g., ECCS flow, debris types, etc.)
  - Did not have sufficient information to model plant piping layout and insulation debris locations.
  - Calculated a range of likely amounts of debris that could accumulate on sump screen and the associated head loss. This head loss was compared to the NPSH margin to determine the likelihood of clogging.

ACRS T/H Subcommittee
February 4, 2003

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Technical Assessment (Cont.)

- Confirmed Recirculation Performance is a Credible Concern for PWRs
  - More and finer debris could be generated by a HELB
  - Sump clogging due to thin bed effect
  - Upstream (inventory loss) and downstream blockage (HPSI throttle valves) concerns
  - Other effects such as loads on screens from debris beds at design conditions

ACRS T/H Subcommittee
February 4 2003

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United States Nuclear Regulatory Commission

Technical Assessment Conclusions

- Plant Specific Analyses should be conducted to determine whether debris accumulation in PWR containments will impede or prevent ECCS operation during Recirculation
- Appropriate Corrective Action, as necessary, should be implemented on the basis of these plant-specific analyses
- The Industry and the ACRS were briefed on the study findings in July and September, 2001,respectively.
  - ACRS agreed with potential issue; developing guidance for plant-specific analyses if needed, and requested review of proposed final disposition

ACRS T/H Subcommittee
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Regulations and Guidance Development (Stage 4)

- NRR Action Plan Developed to Address GSI Resolution
- Revise Regulatory Guide 1.82
- PWR Industry (NEI) to Issue Guidance for Plant Specific Evaluation (Fall 2003)
- Generic Letter

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ACRS T/H Subcommittee
February 4 2003

United States Nuclear Regulatory Commission

LANL Support Activities

- NRR Contracted LANL for technical support
- Provides continuity of GSI issue and related technical support
- Completing a set of calculations for volunteer plant
- Commenting on Industry Evaluation Guidelines
- Addressed testing or knowledge base uncertainties
- Evaluated potential operator recovery actions to complement parametric study results

United States Nuclear Regulatory Commission

Industry Meetings/Initiatives

- NEI PWR Sump Performance Task Force 1997
- Regular Meetings and Conference calls
- Since completion of Technical Assessment:
- March 28, 2002
  - NRC Action Plan addressed
  - Industry Initiative 6 Step program
    - No submittal but will coordinate with NRC
    - Regulatory Implementation for NRC action

United States Nuclear Regulatory Commission

NRC/PWR Industry Meetings (cont.)

- May 30, 2002
  - Presentation/discussion of Condition Assessment Guidelines (NEI-02-01)
- July 2, 2002
  - Review of potential interim actions and regulatory assessment
- July 30-31, 2002
  - NRC attended/presented at NEI PWR Sump Performance Workshop

United States Nuclear Regulatory Commission

NRC/PWR Industry Meetings (Cont.)

- August 29, 2002
  - Revision of Condition Assessment Guidelines (NEI-02-01) for NRC comments and Industry experience
  - Addition of HPSI throttle valve blockage to scope
- October 24, 2002
  - Status of action plan/GL
  - Discuss draft NEI Evaluation methodology ground rules
  - Discuss PCI letter concerning head loss due to fiber/particulate combinations
- November 18, 2002 - ANS Winter meeting session

United States Nuclear Regulatory Commission

NRC/PWR Industry Meetings (cont.)

- December 12, 2002
  - Additional ground rules sections presented
    - General Technical
    - Debris Generation
  - Discussed NRC perspectives on Design and Testing for GSI-191 Resolution
- Planned March 4, 2003
  - Status of action plan/GL/Operator Recovery TLR
  - Discuss NRC comments on NEI Evaluation methodology ground rules received
  - NEI present additional ground rules sections
  - Visit UNM Thermal Hydraulics laboratory

United States Nuclear Regulatory Commission

Current Plans and Schedules

- Issue Draft Regulatory Guide (DG-1107) for Public Comment (February, 2003)
- Issue Regulatory Guide 1.82, Rev. 3 (September 2003)
- Issue Draft Generic Letter for Public Comment (First Quarter, 2003)
  - Following CRGR review
  - Draft GL is predecisional pending CRGR approval
- Issue Generic Letter (Summer 2003)
- Industry (NEI) to Issue Guidance for Plant Specific Evaluation (Fall 2003)

United States Nuclear Regulatory Commission

GSI-191 Resolution/Closure

- Implementation (Stage 6) begins following Guidance development Fall 2003
  - Completes action plan and focus shift to plant specific MPA activity
- Verification (Stage 7) planned though a combination of Audits, inspection activities and GL response reviews
- Leads to effective closure of GSI-191

ACRS T/H Subcommittee
February 4 2003

United States Nuclear Regulatory Commission

PROPOSED GENERIC LETTER 2003-XX "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION AT PRESSURIZED-WATER REACTORS"

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Office of Nuclear Reactor Regulation
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Plant Systems Branch
February 4, 2003

United States Nuclear Regulatory Commission

Package for CRGR Review

- Memorandum to CRGR Chairman
- Attachment 1, Proposed Generic Letter
- Attachment 2, Required Information for CRGR Review
- Attachment 3, Risk Considerations and Benefits Associated with GSI-191
- Attachment 4, Cost Analysis for GSI-191

United States Nuclear Regulatory Commission

Purposes of Generic Letter

- Apprise PWR licensees of NRC research identifying the potential susceptibility of PWRs to containment recirculation sump screen blockage
- Apprise PWR licensees of additional adverse effects due to post-accident debris blockage
- Request that PWR licensees evaluate the ECCS and CSS recirculation functions, and, if appropriate, take additional actions to ensure their reliability
- Require that PWR licensees inform the NRC of the extent to which they will take the requested actions

United States Nuclear Regulatory Commission

Background

- During initial plant licensing, a 50%-blockage assumption was made in assessing the adequacy of sump screens
- USI A-43 research demonstrated the non-conservatism of this assumption in the mid-1980s, but backfitting operating plants was not justified
- BWR ECCS strainer clogging events and research in the mid-1990s justified backfitting for BWRs
- Research and analysis for Generic Safety Issue 191 indicates that generic action is also justified for PWRs

United States Nuclear Regulatory Commission

Phenomenology

- Debris Generation
  - Primarily jet impingement
  - Secondarily temperature/humidity, flooding
- Pre-existing Debris Sources
- Debris Transport
  - Washdown from spray and break flows
  - Transport within pool if turbulence is sufficient
- Debris Accumulation
  - Suspended debris
  - Sliding debris

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February 4 2003

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Concerns Addressed in Generic Letter

- Sump screen debris blockage
  - Potential loss of NPSH margin to ECCS and CSS pumps
  - Potential deformation of sump screens
- Upstream debris blockage at flow restrictions in containment drainage paths
- Downstream debris blockage at flow restrictions in ECCS and CSS

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February 4 2003

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Requested Actions

- Perform a mechanistic evaluation of the susceptibility of the ECCS and CSS recirculation functions to debris blockage
- Assess necessity of, and, if appropriate, implement interim compensatory measures to mitigate the potential for sump clogging prior to performing evaluation
- Implement any plant modifications necessary to restore compliance with NRC regulations

United States Nuclear Regulatory Commission

Basis for Action Request

- GL invokes compliance exception to the Backfit Rule to ensure that PWR licensees are in compliance with:
  - 10 CFR 50.46, which requires long-term core cooling
  - licensing-basis requirements for the CSS
- Simplified cost-benefit analysis justifies compliance backfitting

United States Nuclear Regulatory Commission

Information Request

- GL cites 10 CFR 50.54(f) to require response
- Response is requested in two parts
- Purposes of information request:
  - To ensure PWR licensees have timely plans to perform requested actions
  - To ensure potential risks associated with sump clogging are being adequately managed
  - To elicit information concerning the results of the requested evaluation in support of resolving Generic Safety Issue 191

United States Nuclear Regulatory Commission

Coordination with Industry

- NEI is developing guidance for licensees to evaluate sump screen adequacy
- NEI addressed staff comments concerning guidance for containment surveillances
- NEI evaluation methodology guidance may be more challenging for reaching agreement
- GL tentatively endorses NEI guidance, but provides for potential disagreements

United States Nuclear Regulatory Commission

Draft Regulatory Guide, DG-1107 "Water Sources for Long-Term Recirculation Cooling Following A LOCA"

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Division of Engineering Technology
February 4, 2003

United States Nuclear Regulatory Commission

OVERVIEW

- Reg. Guide Issuance Process
- Historical Background – Reg. Guide 1.82
- Regulatory Position
- Acceptable Analytical Approaches
- Contributions of GSI-191 Research
- Current Plans and Schedules
- Conclusions

United States Nuclear Regulatory Commission

Reg. Guide 1.82, Rev. 3
Issuance Process

- Brief ACRS
- Issue DG -1107 For Public Comment
- Resolve Public Comments
- Brief CRGR/ACRS
- Resolve Comments
- Issue Reg. Guide 1.82, Rev. 3

United States Nuclear Regulatory Commission

DG -1107(Reg. Guide 1.82, Rev. 3)

Background

- Revision 0 – Issued June 1974
  - ❑ NPSH Calculations Based on 50% Blockage of Sump Screen
- Revision 1 – Issued November 1985
  - ❑ Guidance Based on USI A-43 Resolution
- GL 85-22 Concluded that RG. 1.82 (Rev.1)
  - ❑ Would Not Apply to Any Plant Then Licensed to Operate or Under Construction
  - ❑ Would be Limited to Conduct 10 CFR 50.59 Reviews Dealing with Change/Mod of Thermal Insulation
- Revision 2 – Issued May 1996
  - ❑ Revised Guidance for BWRs
  - ❑ Requested Licensee to Implement Measures to Ensure ECCS Functions Following LOCA (NRC Bulletin 96-03)
- Revision 3 – Issue September 2003 (Planned)
  - ❑ Revised Guidance for PWRs

United States Nuclear Regulatory Commission

Regulatory Position

Key Revisions In
DG -1107(Regulatory Guide 1.82 Rev.3)

- Primarily, PWR Sections Revised to Enhance Debris Blockage Evaluation Guidance
  - ❑ Consistent with BWRs Guidance in Rev.2, and,
  - ❑ Insights gained from Research Performed Under GSI -191
- Minor Editorial Changes to BWR Sections

  (Consistent with Staff's Position in Safety Evaluation on BWROG's Response to NRC Bulletin 96-03)
- Includes Guidance Previously Provided in Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps"

United States Nuclear Regulatory Commission

Insights From GSI-191 Research Debris Sources and Generation

- Industry Insulation Survey (1999)
  - ❑ Fibrous
  - ❑ Reflective Metal Insulation
  - ❑ Calcium-Silicate
- Amount of Debris Generation Depends Upon
  - ❑ Type of Insulation Material (Different Destruction Threshhold Pressure for Different Materials)
  - ❑ Proximity and Orientation of the Insulation Relative to Postulated Pipe Break Location
  - ❑ Insulation Installation (Jacketing, reinforcement)

United States Nuclear Regulatory Commission

Insights From GSI-191 Research
Debris Transport

- Substantially More Debris is Transported to Sump Screen Relatively Soon After Switchover to Recirculation
- Fine Fibers are Transported Easily and Remain Suspended for Long Time and Eventually Transported to the Sump Screen
- Fraction of Debris Transport is More for Shallower Sump Pools Than the Deeper ones
- Position (Location & Orientation) of Sump Relative to Break Location Affects the Fraction of Debris Transport
- Narrow Flowpaths (Channels) Accelerate Flow and Enhance Debris Transport
- Debris Curbs Affect Local Flow and Impede Forward Motion of Debris Sliding and Tumbling Along the Floor

United States Nuclear Regulatory Commission

Insights From GSI–191 Research
Debris Accumulation and Head Loss

- Fine Debris Accumulates Uniformly
- Debris Transported Along the Floor
  - ❑ Accumulates Uniformly on Horizontal Screen
  - ❑ Accumulates Near the Bottom of a Vertical Screen Initially
- PWR Head Loss Data is Consistent with the Correlation in NUREG/CR-6224 (BWR Parametric Study, 1995) with Adjustment to Material Property Parameters
- Fibrous Bed in Combination with the Particulate Debris (corrosion Products, Paint Chips, Concrete Dust, Calcium - Silicate) Results in Higher Head Losses

United States Nuclear Regulatory Commission

Acceptable Analytical Approaches

- DG – 1107 describes Analytical Approaches Acceptable to the staff
- LANL Presentation of Analytical Approaches
- Licensee can Propose Alternate Approaches
- Current Knowledgebase of Research on BWR Strainer and PWR Sump Screen Clogging Issue (NUREG/CR)

ACRS T/H Subcommittee
February 4 2003

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United States Nuclear Regulatory Commission

Contributions of GSI-191 Research Program

- Confirmed the Credibility of the Generic Safety Issue
- Supported Agency's Performance Goal of Maintaining Safety by Gaining Knowledge Regarding the Effect of Debris Accumulation on PWR Sump Performance
- Periodic Meetings with the Public, Industry, ACRS, and Other Stakeholders
- Developed Tools (Computer Programs, e.g., CASINOVA, BLOCKAGE) for Staff and Industry Use

ACRS T/H Subcommittee
February 4 2003

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United States Nuclear Regulatory Commission

Contributions of GSI-191 Research Program (cont.)

- Developed NUREG/CRs and Regulatory Guide to Provide Valuable Insights for Resolution of GSI-191
- Developed a Knowledge Base Report Summarizing US and International Research on BWR strainer and PWR Sump Screen Clogging Issues
- Plan to Interact and Share Knowledge on Sump Clogging Issue with the International Community and Other Stakeholders in an International Conference (November 2003 - Tentative)

United States Nuclear Regulatory Commission

Current plans and Schedules

- Issue Draft Regulatory Guide (DG-1107) for Public Comment (February, 2003)
- Issue Regulatory Guide 1.82, Rev. 3 (September 2003)
- Industry (NEI) to Issue Guidance for Plant Specific Evaluation (Fall 2003)

United States Nuclear Regulatory Commission

CONCLUSIONS

- GSI-191 Resolution Process at Regulation and Guidance Development Stage
- Draft Reg. Guide is Scheduled for Public Comment
- Final Reg. Guide Issuance is Planned and Scheduled
- Implementation of Regulations and Verification will Follow
- Lead to Effective Closure of GSI-191

Acceptable Analytical Approaches for ECCS Sump Vulnerability Assessment

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Advisory Committee on Reactor Safeguards
Rockville, Maryland
February 4, 2003

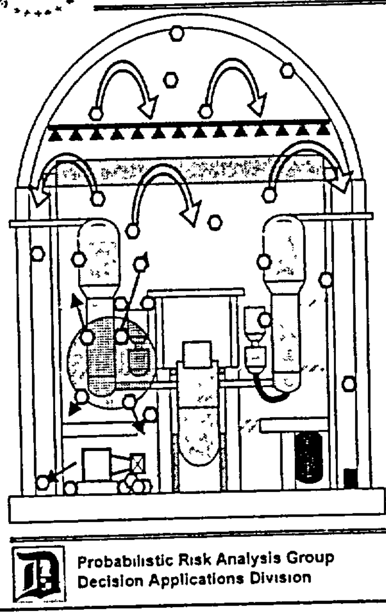
Overview

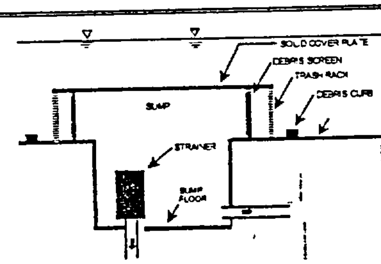
- Introduction
- Debris Generation
  - Break Location
  - Zone of Destruction
- Debris Transport
  - Blow Down/Wash Down
  - Pool Transport
- Debris Accumulation/Head Loss
- Integrated Vulnerability Assessment

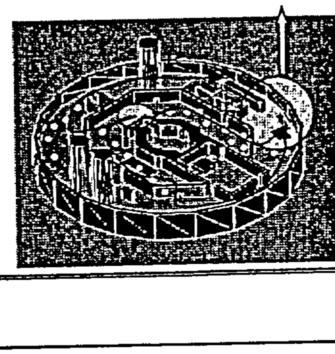
Introduction

Probabilistic Risk Analysis Group
Decision Applications Division

Accident Progression

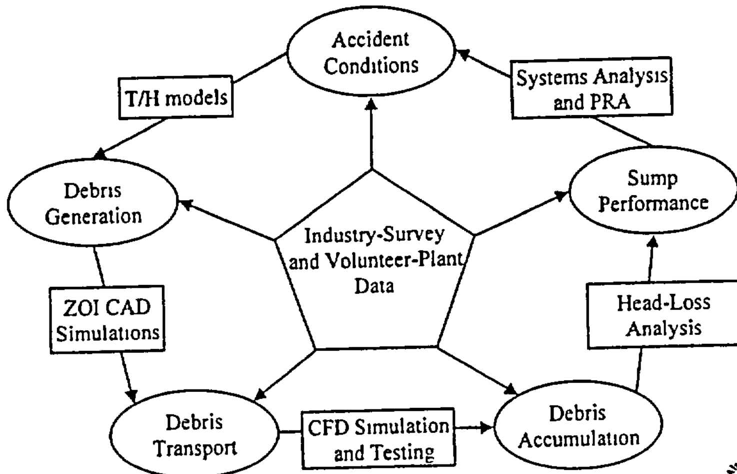






Probabilistic Risk Analysis Group
Decision Applications Division

GSI-191 Program Overview



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GSI-191 Documentation

- Thermal-Hydraulic Response of PWR Reactor Coolant System and Containments to Selected accident Sequences (NUREG/CR-6770)
- Separate-Effects Characterization of Debris Transport in Water (NUREG/CR-6772)
- The Impact of Debris Induced Loss of ECCS Recirculation on PWR Core Damage Frequency (NUREG/CR-6771)
- Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance (NUREG/CR-6762, Vol. 1)
- Summary and Analysis of U.S. Pressurized Water Reactor Industry Survey Responses and Responses to GL 97-04 (NUREG/CR-6762, Vol. 2)
- Development of Debris Generation Quantities in Support of the Parametric Evaluation (NUREG/CR-6762, Vol. 3)
- Development of Debris Transport Fractions in Support of the Parametric Evaluation (NUREG/CR-6762, Vol. 4)
- Knowledge Base for the Effect of Debris on PWR ECCS Performance
- The Impact of Recovery from Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency

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Decision Applications Division

Debris Generation: Break Location

Guidance

- **Break Locations to be Considered:**
  - Hot leg, cold leg, intermediate leg, and (if needed) main steam, and main feedwater with the largest amount of potential debris
  - Large breaks with largest variety of debris (two or more types)
  - Breaks in areas with most direct path to sump
  - Medium and large breaks with largest particulate to fiber mass ratio
  - Breaks that lead to a minimum uniform bed (1/8-inch) to filter particulate debris

Spatial Plant Model Needed for Debris Source Issues

- **Realistic spatial configuration of insulated piping and equipment is important:**
  - Proper distribution of potential break sizes **(debris volume)**
  - Defines regions of high insulation density **(debris volume and composition)**
  - Presence of structure and equipment offers confinement and sheltering **(debris volume)**
  - Spatial correlation between insulation types and break sizes **(debris composition)**
  - Break location relative to sump **(debris transport)**
- **A flexible, efficient model can be used for parameter studies: insulation type, effective damage volume, directional impingement, postulated break location, barriers, etc.**

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CASINOVA Source-Term Analysis

- **Containment Accident Sequence INsulation Outcome Verification Analysis (CASINOVA) model:**
  - Accepts spatial pipe and equipment data cross referenced by reactor system, insulation type, and pipe diameter (ASCII data files)
  - Discretizes insulated pipes into linear segments that are then represented as point targets on the centerline
  - Discretizes equipment blankets into panels represented as point insulation targets
  - Maps spherical damage pressure zones on spatial insulation data
    - BWR URG correlations specific to each insulation type and breakdiam
  - Postulates Guillotine breaks at any set of locations
    - Table of welds correlated with specific pipe sizes and reactor systems
  - Performs CAD-like simulations and compiles statistics on break size, reactor system, debris volume, and debris composition.
  - Developed in MATLAB® to run on a high-end desktop PC
    - Potential for standalone distribution, GUI development, C++ interface

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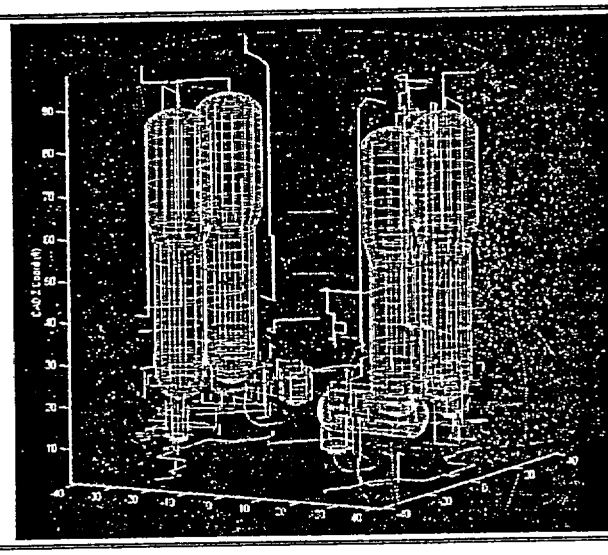
CASINOVA Debris Simulation



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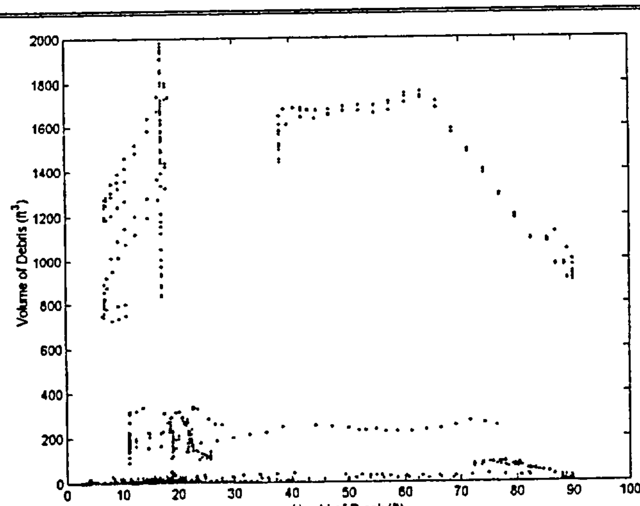
Break Locations



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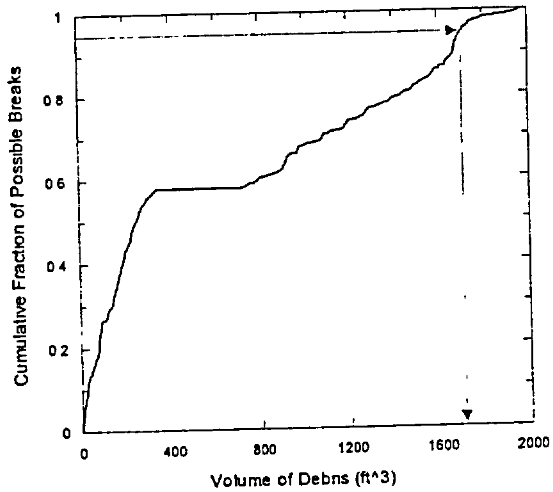
Dist. of LLOCA Debris Volumes



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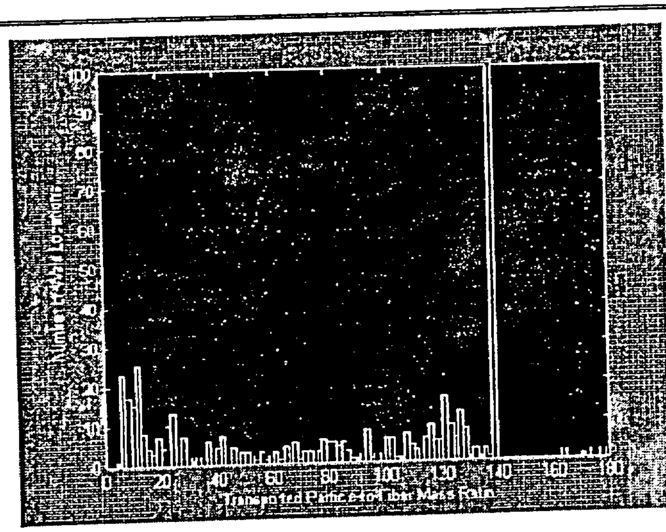
CASINOVA Summary Statistics



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Debris Generation: Zone of Destruction

Guidance

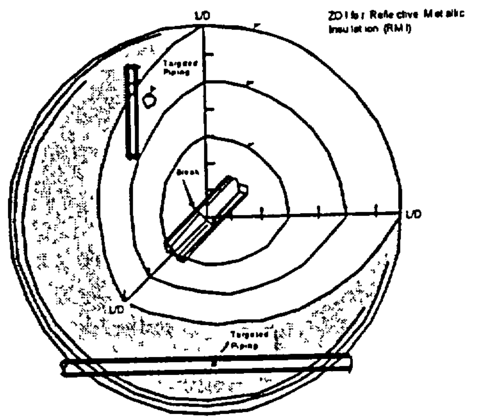
- Spherical Zone of Influence (ZOI) defined by destruction pressure of each insulation type
  - Examples provided in NUREG/CR-6224 and BWROG URG and Staff Evaluation of BWROG response to NRC bulletin 96-03
- The size and shape of ZOI should be supported by analysis or experiments specific to break size and target (destruction pressure)
- The volume of debris contained in ZOI should be used to estimate the amount of debris generated
- The size distribution of debris should be determined by analysis or experiment
- The shock wave and subsequent jet should be the basis for estimating amount and size generated in ZOI (pressure equivalent spherical volume)

Pressure Equivalent Spherical ZOI

ZOI for Fiberglass

ZOI for Calcium Silicate

ZOI for Reflective Metallic Insulation (RMI)

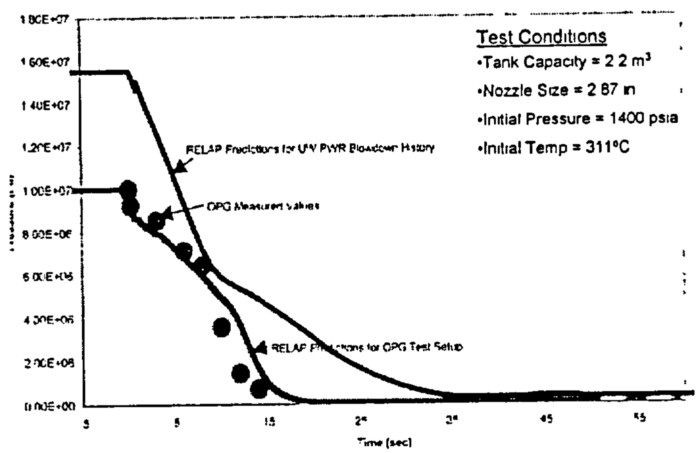


Note
L = Distance from break to target
D = Diameter of broken pipe

BWROG Data

Selected Insulation Destruction Pressures		
Insulation Material	BWROG Recommendation	NRC Confirmatory Analysis Recommendation
Calcium Silicate with Aluminum Jacket	160	150
K-Wool	40	40
Temp-Mat with SS Wire Retainer	17	17
Knaupf®	10	10
Jacketed NUKON®	10	6
Unjacketed NUKON®	10	6
Min-K	4	<4

OPG Calcium-Silicate Tests



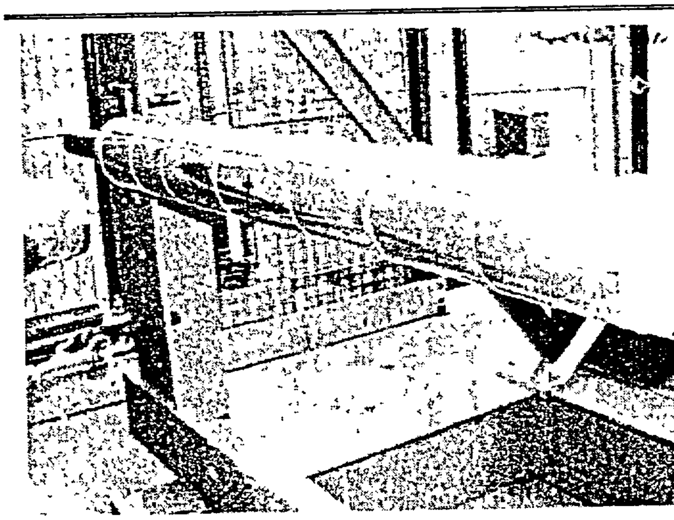
Scaling Analysis

- **PWR blowdown begins @ 2300 psig**
  - Initially flashing water ($x \sim 0$) at stagnation
  - After 10 s stagnation $x = 0.2$. Jets are steam continuum with suspended droplet field
- **Scaling must account for**
  - Higher stagnation pressure compared to BWR
  - Lower quality compared to MSLB of BWR
- **ANSI/ANS-58.2 and EPRI models formed the basis for scaling**

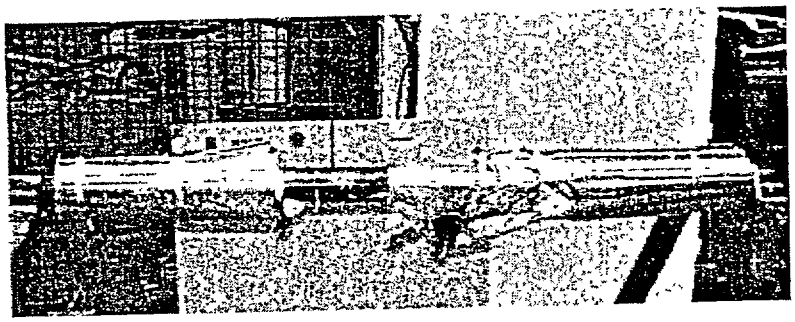
Rederived ZOI for Cal-Sil

- **Rederived using OPG data and analysis approach similar to BWR study**
- **Slightly increased ZOI size**
  - Nukon: 12-D (PWR) vs 10-D (BWR)
  - Cal-Sil: 8-D (PWR) vs 6- D (BWR)
- **Higher fraction of fines**
  - Nukon: 29% (BWR) vs 40% (PWR)
  - Cal-Sil: ≈ 0% (BWR) vs 30% (PWR)

OPG Calcium-Silicate Tests



OPG Calcium-Silicate Tests



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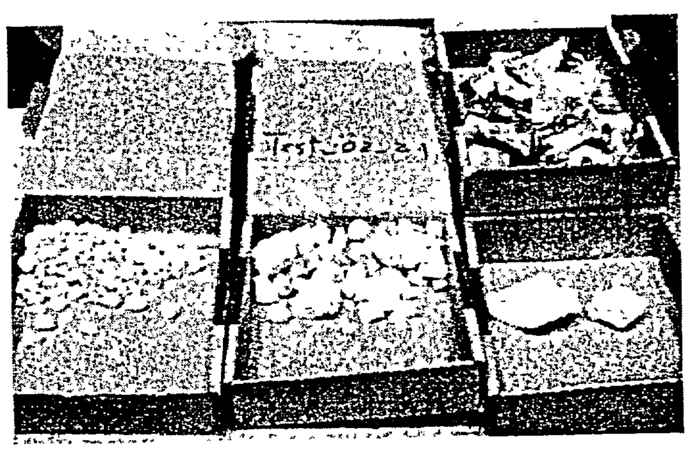
OPG Calcium-Silicate Tests



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Blow-Down/Wash-Down Debris Transport

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Blowdown/Washdown Transport of Debris to Sump Pool

- **Debris Initially Dispersed Throughout Containment by Depressurization Flow**
  - Primary Modes of Debris Deposition
    - Inertial Capture When Flows are Dynamic (e.g , near break)
    - Gravitational Settling as Flows Slow and Turbulence Dissipates (e g., dome region)
- **Transport by Containment Spray Drainage**
  - Spray Transport Processes
    - Capture of Remaining Airborne Debris
    - Debris Washed from Structures
      - Some Areas of Containment Not Directly Impacted by Sprays
    - Debris Entrained by Drainage Flows
    - Entrained Debris Can Be Trapped (e g., Floor Drains)
    - Trapped Fibrous or Particulate Debris Subject to Erosion

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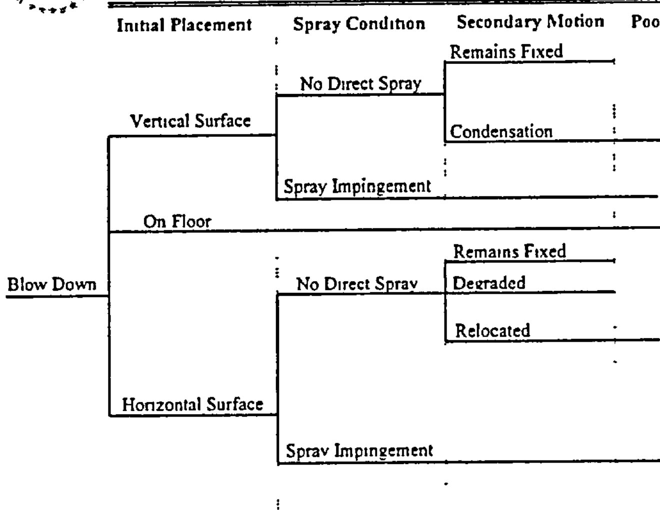
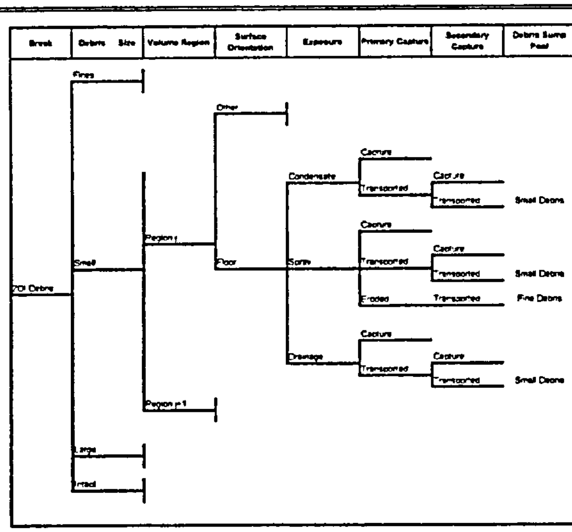
Logic Chart for Transport Fractions (NUREG-6762 Vol 4)

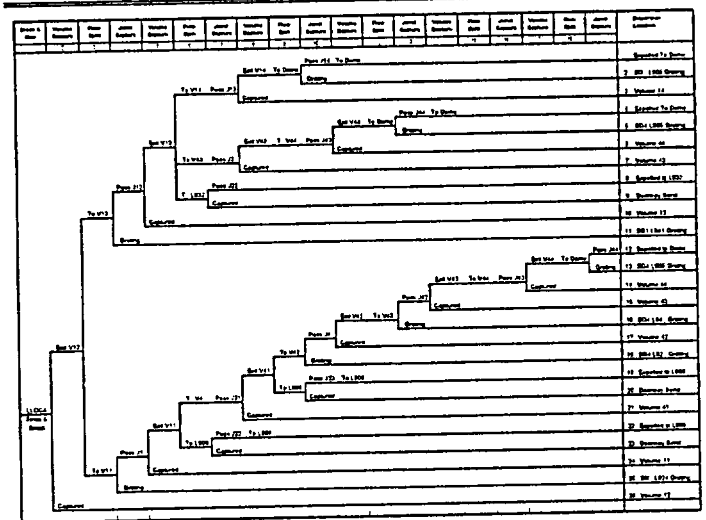


- Logic charts for each debris type and size
- Use different tools for each phase of transport
- Engineering judgment and simple calculations used to quantify branches
- Demonstrates systematic and traceable approach to vulnerability assessment
- Degree of conservatism can be compared to plausibility of physical mechanisms

Example Section of Debris Transport Chart



Transport Chart for Steam Generator Compartment with Break



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Pool Transport

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Debris Transport Analysis (NUREGs 6772 and 6773)

Basic Assumptions:

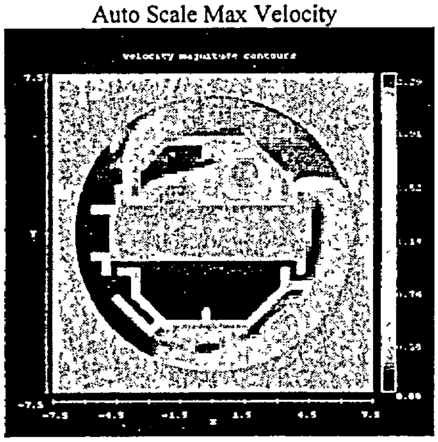
1. Linear flume tests characterized the incipient flow and settling velocities of various debris types and sizes
2. CFD can predict local water velocities (speed and direction)

Approach: (for a given debris size and initial location)

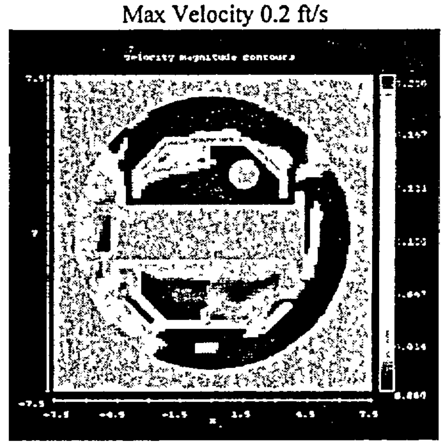
1. Consider contiguous areas with velocities higher than incipient velocity as regions susceptible to transport
2. Conservatively assume migration to boundary of the incipient velocity contour and release from pool surface
3. Consider settling time from surface as an opportunity to drift into another contour or into a stagnant zone (velocity < incipient)
4. Any debris reaching the contiguous contour surrounding the sump is assumed to eventually collect on the screen

Steady-State Velocity Maps (Upper)

Auto Scale Max Velocity

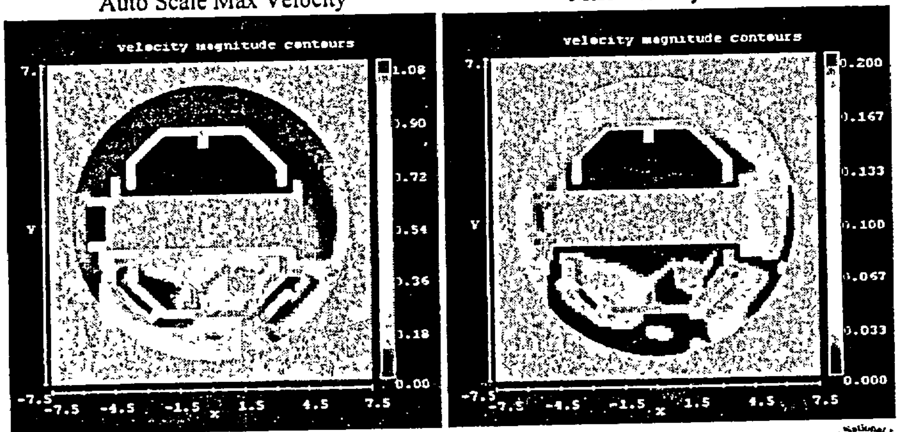


Max Velocity 0.2 ft/s



Steady-State Velocity Maps (Lower)

Auto Scale Max Velocity | Max Velocity 0.2 ft/s



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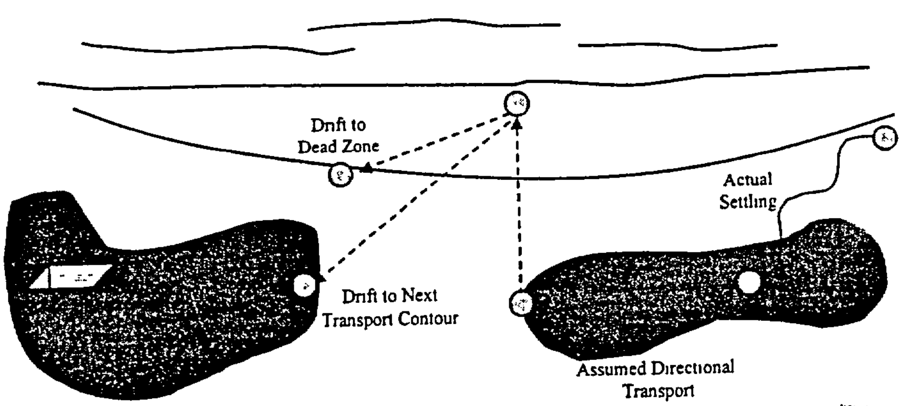
Schematic of Pool Transport



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Observations Regarding CFD

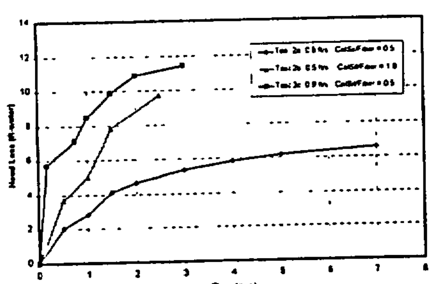
- Good qualitative agreement between CFD models of fill/steady-state velocities and Tank Experiments
- Ancillary sources representing containment spray return paths should be added
  - Particular interest in effect of annular wash down of walls to pool
- Current suite of desktop PCs will permit ~10 break simulations per volunteer plant
- Quantitative flow maps provide access to an approximate, yet tractable estimate of transport fraction
  - Logic maps and engineering judgment will be needed to consider fractions and characteristics of debris returned to the pool via various paths
- Uncertainties in location and timing of debris entering pool limit the need for a high fidelity model of debris transport

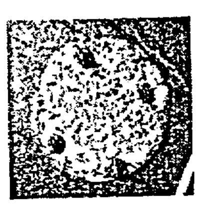
Debris-Bed Head Loss

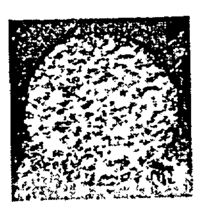
UNM Head-Loss Testing

- **Confirmed that BWR head-loss correlation is robust**
  - Vertical screens
  - Square mesh vs perforated plate
- **Obtained additional data**
  - Cal-sil
  - Aluminum RMI
  - Al RMI + fiber
- **Provided template of analytic technique and accessible facility**
- **MUST use appropriate material properties for head-loss estimates**
  - Sludge density
  - Bed porosity
  - Interstitial velocities

Cal-Sil + Fiber Head Loss



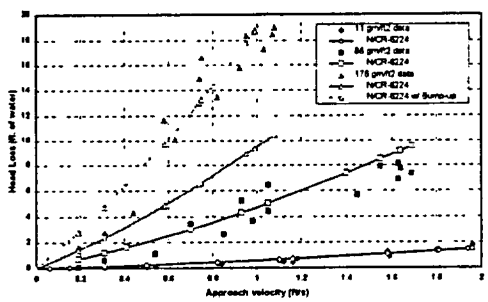




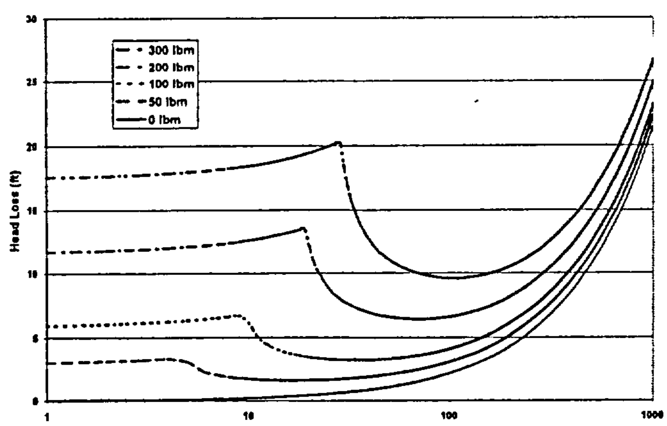
BLOCKAGE Head-Loss Estimation

- BLOCKAGE PC-utility useful for assessing sump-screen vulnerability as a function of debris composition, volume and flow velocity
- Assumes debris bed of uniform thickness and composition
- Head-loss correlations in current BLOCKAGE being updated to include recent tests of additional debris types
- All head-loss correlations in BLOCKAGE will also be incorporated in CASINOVA

Empirical Head-Loss Correlations for Calcium Silicate



BWR Head-Loss Correlation (NUREG-6224)

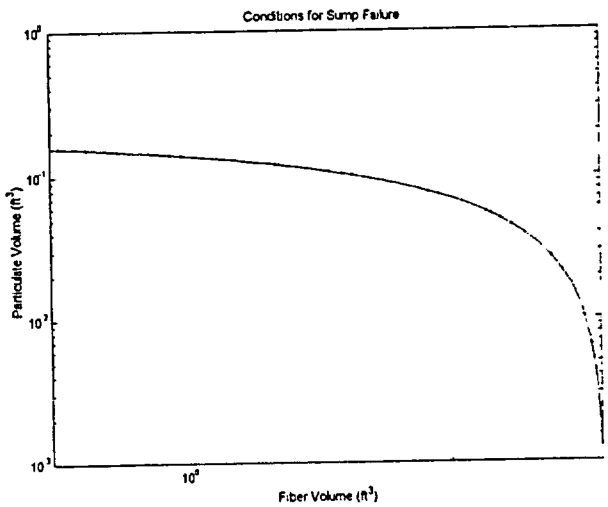


Integrated Vulnerability Assessment

Available Analysis Resources

- Debris Generation and Transport Test References
- Knowledge-Base Report (Sump-Blockage Source Book)
- Comprehensive Composite Plant Analysis
  - Spatial Logic Diagrams
  - CFD examples
  - Application of Transport Estimation
  - Application of CASINOVA and BLOCKAGE
- CASINOVA Debris Volume Simulation
- BLOCKAGE Head-Loss Estimation Utility

Conditions for Sump Failure



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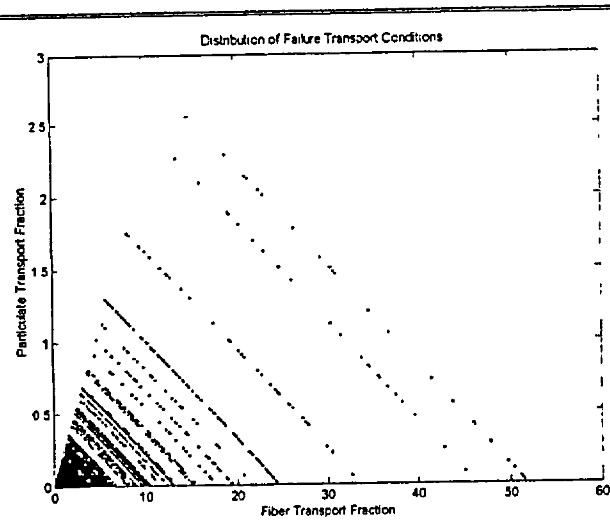
Transport Required for Failure



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Industry Activities to Address PWR ECCS Sump Performance

Advisory Committee on Reactor Safeguards
Thermal-hydraulic Phenomena Subcommittee
February 4, 2003

John Butler
Senior Project Manager
Nuclear Energy Institute
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NEI

Industry GSI-191 Activities

- PWR industry is taking the lead in developing methodology for plant-specific assessments of ECCS sump performance
- Presentation will address:
  - Who is involved in industry activities?
  - What activities are underway?
  - When activities are scheduled to be completed?

NEI

Industry GSI-191 Activities

- Industry activities are a coordination of efforts
  - NEI PWR Sump Performance Task Force
  - WOG/CEOG
  - B&WOG
- NEI Task Force includes representatives from
  - PWR Owners Groups
  - PWR utilities
  - EPRI
  - EDF
  - consultants

NEI

Industry GSI-191 Activities

- Activities currently underway fall into three general categories:
  - Coordination, collection and evaluation of data applicable to ECCS sump performance
  - Development of ECCS sump performance evaluation methodology for application by PWR plants
  - Communication of industry and regulatory activities to PWR plant operators

NEI

Data Collection and Evaluation

- Coordination, collection and evaluation of data applicable to ECCS sump performance is an ongoing effort performed in parallel with methodology development
- Research data (Industry, NRC, International) must be evaluated to determine its applicability to U.S. PWR conditions
  - Identified data gaps will need to be filled by obtaining additional data or be addressed in conservative manner

NEI

Data Collection and Evaluation

- Plant data covering debris sources, programs and designs are needed to support methodology development as well as plant-specific implementation of guidance
  - NEI 02-01, Condition Assessment Guidelines: Debris Source Inside PWR Containments addresses potential debris sources

NEI

NEI-02-01, Debris Sources Inside PWR Containments

- Issued to all PWR plant operators
- Document offers guidance to:
  - Identify, locate and characterize potential sources of debris that could challenge the post-accident operability of the containment sump
  - Perform containment walkdown surveys to verify or supplement design or maintenance documentation
- Revision 0 issued in April 2002
  - Pilot application at several plants
- Revision 1 issued in September 2002
  - Addressed comments received from pilot plants and NRC

NEI

NEI-02-01, Debris Sources Inside PWR Containments

Purpose

- Document information to support plant-specific sump performance assessments
- Identify potential debris sources inside containment resulting from affected design basis events
- Perform supporting walk-downs:
  - Verify current as built conditions
  - Focus on location and amount of insulation materials, unqualified coatings, foreign materials

NEI

ECCS Sump Performance Evaluation Methodology

- Guidance will address methods for assessment of sump performance and actions that can be taken to address assessment findings
  - Develop analytical tools, methods and guidance for debris generation, debris transport, debris accumulation and pressure drop across the sump screen
  - Perform sensitivity analysis
  - Develop decision analysis tools

NEI

ECCS Sump Performance Evaluation Methodology

- Completion of Evaluation Methodology is scheduled for September 2003
  - Plant-specific implementation would follow
- Frequent status meetings held with NRC during development period
- "Ground rules" provide outlines of methodology development to facilitate discussions
- Impact of Regulatory Guide and Generic Letter on methodology development and schedule will be evaluated following release for public comment

NEI

Industry Communication

- **Written correspondence:**
  - Provides updates on ongoing task force and regulatory activities
  - Distribute draft documents for comment and review
  - Issue finalized guidance along with recommendations for use
- **PWR Sump Performance Information Forum website**
  - Internet based website used to augment more traditional communication tools
  - Provides benefit of easy access by all staff levels within a company
  - Facilitates distribution of GSI-191 research reports and NEI PWR Sump Performance Task Force guidance materials
  - Provides a forum for discussion among PWR plant operators

NEI

Industry Communication

- **Industry Workshops**
  - Workshops are being conducted to provide forums for instruction and use of guidance and transfer of information
  - First workshop conducted July 30-31, 2002 and focused on NEI 02-01
  - Second workshop tentatively scheduled for Summer 2003
  - Implementation workshop following issuance of evaluation methodology being considered

NEI