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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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MEETING OF THE

SUBCOMMITTEE ON THERMAL HYDRAULIC PHENOMENA

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TUESDAY,

MAY 15, 2007

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The meeting was convened in Room O1G16, 11555 Rockville Pike, Rockville, Maryland, at 8:30 a.m., GRAHAM B. WALLIS, Acting Chair, presiding.

MEMBERS PRESENT:

GRAHAM B. WALLIS, Acting Chair

SANJOY BANERJEE, Vice Chair

SAID ABDEL-KHALIK

THOMAS S. KRESS

ACRS STAFF PRESENT:

ZENA ABDULLAHI Designated Federal Official

NRR STAFF PRESENT:

ERVIN L. GEIGER

PAUL KLEIN

JOHN LEHNING

SHANLAI LU

MICHAEL SCOTT

ROBERT L. TREGONING

STEVEN UNIKEWICZ

ALSO PRESENT:

JOHN BUTLER Nuclear Energy Institute

I-N-D-E-X

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

INTRODUCTION

CHAIRMAN WALLIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Thermal-Hydraulic Phenomena.

I am Graham Wallis. I am acting as the chairman of the Subcommittee for today. Subcommittee members in attendance are Tom Kress, Said Abdel-Khalik, and we expect Dr. Sanjoy Banerjee momentarily.

The purpose of this meeting today is to discuss the progress being made by the NRC staff and the licensees in the resolution of generic safety issue 191, PWR sump performance. Representatives of the Nuclear Energy Institute, PWR owners' group, and several vendors of PWR sump screens will present the results of their GSI-191 implementation activities, including program plans to design new screens for PWR sumps to address chemical interactions of coolant and debris within a containment during a loss of coolant accident and to address the impact of debris on components downstream of the sump screens.

The NRC staff will also discuss the plant-specific audits conducted in support of the implementation of GSI-191. Several PWR licensees will present their plant-specific GSI-191 resolution program activities and status.

The Subcommittee will hear presentations by and hold discussions with representatives of NEI, the PWR owners' group, the screen vendors, the NRC staff, and other interested persons regarding these matters.

The Subcommittee will gather information, analyze relevant issues and facts, and formally propose positions and actions as appropriate for deliberation by the full Committee. Zena Abdullahi is the designated federal official for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on May 2nd, 2007.

Portions of this meeting may be closed to discuss proprietary information. Notice of closure of these portions has been provided in the draft agenda posted on the NRC Web site.

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

Now, I understand that for two days, we are going to hear almost entirely from the industry. The staff has a short presentation that Mike Scott will commence soon at the beginning, and then it has one at the end. I notice in my introduction I made a statement about the staff discussing plant-specific orders.

MR. SCOTT: There are actually four staff presentations. I don't know how that --

CHAIRMAN WALLIS: Are they going to fit in between? I see. I guess I missed some. They're going to fit in after each one of the industry ones. We're going to have staff comments.

MR. SCOTT: Right. Well, after the chemical effects, WCAP discussion, --

CHAIRMAN WALLIS: Right.

MR. SCOTT: -- we will have a staff presentation and after the downstream effects, the same thing and --

CHAIRMAN WALLIS: Are they going to discuss the audits after we hear from each plant or not?

MR. SCOTT: I believe the audits are last thing to do.

CHAIRMAN WALLIS: That's it. That's the very end. Okay. All right. I just hope that we hear enough from the staff. That's why I sort of interjected that.

MR. SCOTT: And you will hear from the staff today. I have to put one caveat in there, Dr. Wallis, and that is that the industry presentations are quite lengthy. And while we have seen them, we have not integrated a review of them. So whatever reaction we have to those today will undoubtedly be caveated.

CHAIRMAN WALLIS: Yes. But I would like if you have any new audits -- we have seen some audits, some of which seem to be quite old. If you have any new information about audits, I think we would be very happy to hear them.

MR. SCOTT: Okay. We do have some new information. As a matter of fact, two of the audit reports have just been made or I guess one of them has just been made public and another one is in the process of being made public. I think we sent those to you through Zena but only in the last few days.

MS. ABDULLAHI: Yes. The ones that you sent us, I did provide it to the members.

MR. SCOTT: Right.

CHAIRMAN WALLIS: But that was very recently.

MS. ABDULLAHI: The other one --

CHAIRMAN WALLIS: That was the very recent ones.

MR. SCOTT: But you have got to remember that when you talk in terms of these audit reports, recency is those are recently approved. The audit visits actually occurred last year. It takes quite a bit of time.

CHAIRMAN WALLIS: That's why they're so old. It took you a year to approve the document.

MR. SCOTT: No, it doesn't take a year, but it does take several months.

CHAIRMAN WALLIS: Okay.

MR. SCOTT: And so that is why they appear to be a bit dated to you.

CHAIRMAN WALLIS: That is often a bit of a mystery for me. While I don't want to introduce on your presentation, Mike, please go ahead and tell us what you have prepared. Then we'll get on with the meeting.

1. OVERVIEW/INTRODUCTION

MR. SCOTT: Okay. Great. I'm Mike Scott, Chief of Safety Issues Resolution Branch in NRR. And, as several times before when I have appeared before you, I am the lead in NRR for resolution of GSI-191. And I am pleased to have the opportunity to talk to you today and to present the presentation that I think you will find least interesting of all the ones that we are going to talk about today. So we'll move through it hopefully fairly quickly.

I would just like to give you an overview of where we are going with this thing and just kind of keep you up to date on our progress and then just sort of set the stage for the rest of the presentations.

Slide 2, please. The purpose of it is to provide you an update and discuss the path forward as before.

Slide 3. Our current focus, the staff still after all, we have gone back and forth with trying to get this issue resolved. We still expect consistent with generic letter 04-02, that the licensees will address GSI-191 by the end of this year.

CHAIRMAN WALLIS: Mike, the approach seems to be to build it and then show that it works.

MR. SCOTT: I hadn't exactly heard it put that way, but that's not far off.

CHAIRMAN WALLIS: Usually the inverse way of usually designing things.

MR. SCOTT: As you know, when we talked about this thing the better part of a year ago, the staff put a lot of emphasis on making the strainers larger. And the industry bought into that approach. And they have been out doing that.

So at this point -- let's see. We're in Spring '07. I would estimate that probably half of the PWRs have actually massively enlarged their strainers. And they did so with the knowledge that there were unanswered questions and that additional changes might be needed. And we are absolutely still in that mode.

We expect, however, that the licensees by the end of this year will provide a demonstration that adequate long-term core cooling is maintained in the presence of the expected plant-specific degree loading. That, of course, is what is reflected in generic letter 04-02. That is the mission here, so to speak. And that hasn't changed.

However, as you will hear today and tomorrow, the chemical effects testing is just now starting and will go on into the fall and probably until late fall for some of the plants. So it is possible that some of the plants who are late in the queue, so to speak, to get their chemical effects testing done may seek additional time to finish their corrective actions. We have not been formally approached by any particular plant yet, but that may happen in the future.

CHAIRMAN WALLIS: I think the ACRS has been urging you for some time to get this done so that we didn't get surprises after everything has been installed.

MR. SCOTT: Get what done?

CHAIRMAN WALLIS: I guess to get the chemical effects being sorted out.

MR. SCOTT: Sure.

CHAIRMAN WALLIS: Right.

MR. SCOTT: And we are very eager to do that. What is going on now, as you will hear, is the finalization of the review of the chemical effects topical report, which is important for the chemical effects testing, and the vendors, of which you may recall there are about five, are off building their test rigs, to include chemical effects testing. Because there are a limited number of vendors, that means that there weren't any one test facility that is going to see tests for multiple licensees. And so they have to queue up. And that is in large part why this is going to stretch out into the --

CHAIRMAN WALLIS: Is the ANL work continuing for the NRC, the work at Argonne on chemical effects? Is that continuing or is that finished?

MR. SCOTT: That work is finished, I believe. Is Rob Tregoning or Erv Geiger here? Finished, we are told. We are going to talk to you today about the possibility of some additional work that might be done.

Slide 4. We have granted 15 plant-requested extensions for completion of one or more corrective actions. Those requests and our response to them are on the PWR sump Web site.

Most of them are out in the Spring 2008. Those were for plants that did their refueling outages where they installed most of their modifications back in Fall '06 but had one or more items that needed to be done for various reasons in the next refueling outage. So we have a number of plants who have asked for three, four-month extensions.

One plant, Diablo Canyon, sought and received an extension into Spring 2009. They had a situation where they had certain difficult-to-access insulation on their steam generators that were fibrous insulation. And it did not make sense for them given that they are going to replace their steam generators in 2009 to replace the insulation in '07 and then turn around and replace it again in '09.

And they made a strong argument as to why it was safe to not replace them now, that particular piece of insulation. So they got a longer extension.

We believe we will likely get more requests, for one reason or another, as we go through the rest of 2007.

CHAIRMAN WALLIS: I hope you don't get 69.

MR. SCOTT: I hope we don't get 69 also.

Slide 5. Current staff activities. As you know, we are doing audits of a sample of licensees and strainer vendors. And you will hear more about that in Leon Whitney's presentation later.

This is kind of misleading. We are not actually out auditing the strainer vendor. We are going to licensees, each of whom has a strainer vendor. And we believe that the issues identified at a particular licensee that has a particular strainer vendor are likely to be somewhat common with other licensees who have the same strainer vendor. And so we are attempting to get a representative or a reasonable sample of each of the vendors by auditing their customers.

We are continuing to meet with the industry. We are meeting essentially every other month with the industry to discuss remaining technical issues. That is with NEI and the licensees. And a number of other technical discussions are going on, for example, in the review of the topical reports. We are having weekly phone calls typically to try to resolve open technical issues dealing with those topical reports.

And we are finalizing the review of two topical reports and about to get into the review of a third. And you will hear about that today as well.

And we are also just now getting into reviewing the vendor protocols for integrated head loss testing. We received a couple of them in-house and have begun to provide comments back to those vendors to try to make sure that staff comments and concerns, if any, on the chemical effects testing, the integrated head loss testing that includes chemical effects, is done satisfactorily the first time such that there is no need for yet another round of testing.

CHAIRMAN WALLIS: The major question that we raised in our letters, the ACRS letters, was how are you going to take these results from integrated head loss testing and apply them to a plant? And now you say you're getting into the question of reviewing the protocol. Those seems to be a very important item.

MR. SCOTT: It is. We view it as important. We are attempting to get all of the protocols in-house to look at. It's a process that takes some time. Yes.

Slide 6. Near-term plans. We plan to continue the audits. We plan to do the last audit in January 2008, as you will hear from Leon Whitney. We are continuing to work to address the remaining technical issues. And we will talk about that today.

We are beginning now the development of safety evaluations for the chemical effects topical report and the downstream X vessel topical report.

And we are beginning development of additional review guidance that we're going to need to support closure of generic letter 04-02. That draft review guidance should be available in the fall.

Slide 7. We are working with the industry to develop a content guide for the level of detail needed for the generic letter submittals. Their goal is to know exactly what we expect them to provide us so that they get it right the first time. We have the same goal.

And so we are going back and forth in public meetings discussing potential content for these generic letter submittals, which we expect to receive for most plants, again by the end of this year.

CHAIRMAN WALLIS: So it's interesting, again, to look at the time line. I mean, they build the strainer. And then they do some tests which may have some problems. And now you're developing a content guide for what they need to submit. I would think the sooner you could have done that, the better so that they know what to work towards.

MR. SCOTT: I would argue that they know what to work towards, regardless of what we actually tell them to send in to us by mail on 12/31.

CHAIRMAN WALLIS: We would hope so.

MR. SCOTT: Because what they're going to send in is a small fraction of what they are actually going to do. We are not going to ask for each and every one of their references to come in here on 12/31/07.

So I guess my view is that our time line for developing this content guide at this point is timely because I don't think many of them start --

CHAIRMAN WALLIS: This is a dynamic process. But what you ask for depends on what you have seen in your orders to some extent. You've got to know what questions to ask by what you have observed.

MR. SCOTT: I would say that it's a little more accurate to say that the licensees will learn from the audit reports if they look at them, which we are encouraging them to do, what the issues are that need to be addressed in their resolution of GSI-191, not necessarily what needs to be sent in to us on 12-31-07, although they're related, clearly.

What we are expecting on 12-31-07 is the conclusions that lead the licensee to believe that it has resolved the issue and a basis at one level of detail for what that conclusion in. In other words --

CHAIRMAN WALLIS: Okay. Now, which of these things and at which time in your process do you want to interact with us?

MR. SCOTT: That's coming. That's coming. It's the last slide.

CHAIRMAN WALLIS: Okay. Okay.

MR. SCOTT: I'm coming there.

CHAIRMAN WALLIS: So since we're on slide 7, do you want us to look at this content guide?

MR. SCOTT: I honestly don't. You're welcome to. I don't think it would interest you particularly. It's process more than it is technical information. And typically I believe you all aren't all that interested. And I'm happy to provide you a copy of what we have done.

CHAIRMAN WALLIS: We are very interested in the technical information.

MR. SCOTT: Right. And that won't --

CHAIRMAN WALLIS: That won't be somewhere else?

MR. SCOTT: Well, again, it is a request to send in technical information. If you are interested in it, I would be happy to provide you a copy.

PARTICIPANT: I guess we might be interested in what sort of technical information.

MR. SCOTT: Okay. Well, we will get you a copy. We anticipate discussing that in our more final form with the industry in June. And at that point, we will have something that we can be a little more confident of. And we will send you a copy. And that will be available to you before we next meet.

The other thing we are doing right now is soliciting remaining staff technical questions and considering how to resolve each one. From a management perspective, we are very interested in having all of the technical questions out on the table now and not out on the table in Spring 2008, when the licensees send their responses in.

So we are asking the staff based on what the staff knows now to identify what issues the staff members involved with this issue believe have not been adequately addressed.

From each of those items, we have a working group that is considering what is to be done with them and a recommendation for how to proceed. And you can see in the sub-bullets on slide 7, if there is considered to be a technical basis for the concern, that it might be an industry action that is called for. It might be NRC-sponsored research. And it is possible for some of these items that we can justify no action for them at all.

That is going to be documented. And it, too, will be discussed with the industry in June. So you all might want to be represented at that meeting. You might hear some interesting things. And we will get you a copy of our documentation that supports that.

PARTICIPANT: When is that meeting?

MR. SCOTT: I believe June 18th, John.

MR. LEHNING: I believe so.

MR. SCOTT: June 18th. One day, all day I believe is the way it is going to turn out.

Slide 8. Challenges. And this won't be a revelation to the Committee. Many plants have not yet successfully completed chemical effects testing. Issues continue to arise as we go through the process. As before, there is a tremendous variance among the licensees in the level of the concern of the issue and what the solution to it is.

You have some very low-fiber plants, who largely consider themselves to be done now. And you have other plants that are still struggling to show success given their plant-specific debris loading and chemical loading.

As you know, we have been directed by the Commission to resolve the issue holistically; that is, to consider various options and proposals that will support resolution of the issue. And it will allow us to reach reasonable assurance in the presence of the complexities and uncertainties that are of major --

CHAIRMAN WALLIS: Now, what does "reasonable assurance" mean?

MR. SCOTT: Reasonable assurance is

defined as -- I mean, I don't have a definition, but --

CHAIRMAN WALLIS: Well, let me ask you if you mean something like this. You will make an assessment of the bulkage of the strainer and of the core if it happens, and you will calculate the temperatures at various places, flow rates, and so on, and see if there is any damage to the fuel. Is that the kind of thing that is expected to be done?

MR. SCOTT: The regulation that is applicable here is 10 CFR 50.46(b)(5). I mean, it is of the nature that you are talking about. Now, we are not going to do those calculations. The licensees are. And we are going to review.

CHAIRMAN WALLIS: You will expect them to do those calculations?

MR. SCOTT: They are expected to show that for their plant-specific debris loading and transport, that adequate core cooling is maintained using either the methodologies that are provided in our SE that we issued in 2004 or our review of the topical reports that are ongoing now and various things.

If they choose to use those methodologies, then all they need to show is that they are correctly applied. If they choose to do those methodologies, then they have to justify their deviation. That is how we get to reasonable assurance.

CHAIRMAN WALLIS: So we are talking about temperatures in the core that could be high, I mean, up to 1,500-2,000 degrees or something?

MR. SCOTT: You may be aware that there is a topical report coming in from the PWR owners' group on May 31st.

And is Moe here? Is that still on schedule?

MR. DINGLER: That's correct.

MR. SCOTT: Still on schedule, 11:59 p.m., May 31st we're going to get --

CHAIRMAN WALLIS: Are you going to tell us what happens when debris meets a surface which is at 2,000 degrees Fahrenheit?

MR. DINGLER: That's correct.

CHAIRMAN WALLIS: You are going to tell us? Okay. Thank you.

PARTICIPANT: Are we going to review this report?

MR. SCOTT: Yes, we are. And we are going to write an SE on it.

PARTICIPANT: (Inaudible.)

MR. SCOTT: Say it again?

PARTICIPANT: You are going to write an SE?

MR. SCOTT: We are going to write an SE, yes. And it will be a quite accelerated development if you consider how long it usually takes to develop the topical report review. We're going to be quite busy.

PARTICIPANT: And we can see the SE and the report?

MR. SCOTT: Yes. You can see the report as soon as they turn it in, of course, which is now just two weeks away. And the SE obviously is a few months away. And so then we will have the answer to those kinds of questions.

CHAIRMAN WALLIS: Well, this SER is not very good. Don't blame us if we hold you up.

MR. SCOTT: Of course not.

CHAIRMAN WALLIS: Thank you.

PARTICIPANT: Is there sort of a critical path to resolving this?

MR. SCOTT: I would say that the biggest challenge that we have right now is -- well, there are actually two things. One is the fact that the chemical effects, as you know, continue to have a number of unknowns. And the testing has happened yet.

And we don't know what that testing is all going to show.

It is quite possible that as licensees do that testing, they will find that they still need to make additional modifications. And that could slow the process down.

The other thing that we have to do is an expeditious but, yet, quality job of reviewing the in-core topical report, which we don't yet have in-house.

So those are the two things that I think are toughest out there. We believe we have the path forward on downstream effects X vessel. And we are close to finishing the review of the topical report on that, as you will hear.

The head loss testing and the various aspects of that, exclusive of chemical effects, we believe we have got a handle on. And the industry does, too. But it is a busy rest of 2007 to get all of that stuff done.

Let's see here. Next to last bullet. Some complex issues still being resolved. Of course, that's true. That has the potential to slow us down as well. And there is a possible need for additional confirmatory NRC-sponsored research.

Now, as you know, we have been saying to you all for several meetings that we had that in mind. And we are going through a process now, a process that I mentioned to you a couple of minutes ago about dealing with staff issues as well as the process of dealing with the chemical effects peer review panel results that you will hear about later today.

Those processes may well lead us to the decision that some confirmatory research is needed. So we will be able to report that to you the next time we meet with you.

PARTICIPANT: Are you going to talk to us at all about your responses to the peer review panel this round or --

MR. SCOTT: Yes. Well, what you are going to hear are some sample responses, yes. I am kind of stealing Rob Tregoning's thunder here. Rob will be speaking to you. Rob and Erv Geiger will be speaking to you about the status of that effort. And the working group that is dealing with it has met several times.

I believe they have gone through their first round of meetings. And they're sort of taking a cut at the list. But it is not ready fully yet. But you will get an idea of what our thought process is from that presentation later today.

Slide 9. This is sort of off the topic of GSI-191, but I wanted to simply mention it to you because we are thinking about it and you all may have had some thoughts about it as well.

If you go back to the treatment of the BWR strainer clogging issues back in the 1990s and you compare it with the treatment of the PWR sump clogging treatment in the 2000s, then you will find some differences.

We did that. We went back and developed sort of a draft white paper that says for these various issues, for example, X vessel downstream effects and chemical effects and so on, here is the difference in treatment between the BWRs and the PWRs. And there are a number of potentially significant differences in the treatment.

Now, how does that play out as for whether one is right and one is wrong or one is better and one is not so good is not entirely clear. They have evolved to where they are for various reasons, one being the difference in time that the issue is resolved, another being the reactor configurations are different, the core configurations are different, and so on and so on.

But there are differences. And so we have sort of catalogued those, and we are internally discussing, as you can see on the last bullet here, how to proceed with that.

What we would like to do is get out of the mode that the industry and the agency have been in for the last 20 years of addressing one, then the other, and then back to the first and back to the second and so on. We would like to reach regulatory stability on this issue. And we are trying to figure out the best process for doing that.

And the other point, of course, that comes up is new reactors. And the sump strainer guidance for new reactors is not necessarily going to be clear for those new reactors. You can't say, "Well, AP1000 is a PWR. So I'll just invoke the PWR guidance because the strainers have different purposes in those new reactors in some cases." In some cases, maybe they don't.

So there are various loose ends here, if you will, that we are going to consider how to clear up, whether it makes sense to let the disparities continue or whether we need to address them in some manner.

So this is just letting you know that we are thinking about this. And we will undoubtedly be talking to you about it at some time in the future.

Slide 10.

MEMBER BANERJEE: What sort of approaching are you taking to say if somebody comes and says, "We don't need any buffer"?

MR. SCOTT: Well, nobody has done that yet. So I guess the easy answer to your question is no approach at all.

There has been research that we have been advised of that occurred in France that appeared to indicate that a buffer might not be needed for some period of time following a LOCA. Now, it didn't say never needed. It said for some period of time.

We believe that additional work is needed before we reach a conclusion based on that research.

MEMBER KRESS: (Inaudible.)

MR. SCOTT: Yes, it is.

MEMBER KRESS: (Inaudible.) indicate that the buffer wasn't very useful at all.

MR. SCOTT: It was not a player in the iodine issue, at least for that period of time.

MEMBER KRESS: (Inaudible.)

MR. SCOTT: Right. There are other issues that come up in the absence of the buffer, however.

PARTICIPANT: Corrosion or something?

MR. SCOTT: Potentially, yes. So all I'm saying is we're looking at that, but it's not ready for reaching any regulatory conclusions in our view.

PARTICIPANT: Is that an area you think more research could be done? (Inaudible.)

MR. SCOTT: It is certainly an area where more research could be useful. We are not considering it in the same light because it is not part of the current solution set for GSI-191.

MEMBER KRESS: Would that completely address the chemical effects issue?

MR. SCOTT: Well, I would say that it would have an impact, but, again, there might be other things going on by the absence of it. I think I would be reluctant to say that it would resolve chemical effects and we're done. It would certainly change a lot of the issues, but you know how these things are. You make a change. And then some new unexpected --

PARTICIPANT: (Inaudible.)

MR. SCOTT: Yes.

CHAIRMAN WALLIS: Especially on the sump issue.

MR. SCOTT: Right, particularly on the sump issue. So we certainly are not declaring victory or contemplating declaring victory based on that research at this point. But it's interesting.

PARTICIPANT: (Inaudible.) deposition. You know, the peer review committee brought this up (Inaudible.) deposition on the fuel (Inaudible.).

MR. SCOTT: I'm not going to be able to speak to that. Do we have somebody here from the staff who would like to answer that question? Let's see. Rob or Paul Klein or somebody? Paul, do you want to jump on that one?

MR. KLEIN: Paul Klein, NRR.

No, not really, Mike.

(Laughter.)

MR. SCOTT: I teed it up for him.

PARTICIPANT: This is not a loaded question. I'm just asking it out of curiosity.

MR. KLEIN: Yes. There may be changes related to quite different pH's. I'm not sure that we're in a position to discuss that today. But based on some of the experience from overseas testing as well, we would expect there might be a different set of problems associated with lack of buffer in the pool, such as zinc corrosion that's not currently an issue.

So though removing the buffer may be

attractive overall, there are a number of technical questions that would still need to be addressed.

CHAIRMAN WALLIS: Let me go back now. Most plants or many plants have already installed strainers I understand.

PARTICIPANT: I would say around half at this point, yes.

CHAIRMAN WALLIS: And presumably for the others since they are aiming to finish by the end of the year, the strainers have been built.

PARTICIPANT: Or are being built currently, yes.

CHAIRMAN WALLIS: Very close to completion.

PARTICIPANT: Right. They will be built just in time for the fall.

CHAIRMAN WALLIS: So one of the few things you can change later is the chemistry. And you have already got these strainers installed. And then you decide that you've got a problem. One of the things you could change relatively easily might be the chemistry.

PARTICIPANT: The chemistry could be changed. Additional fibrous insulation could be removed. There are various options out there.

CHAIRMAN WALLIS: You don't want to go in and rebuild the strainer.

MR. SCOTT: Well, you know, in a lot of cases, these strainers are very, very large. In some cases, they are all that will fit.

CHAIRMAN WALLIS: Right.

MR. SCOTT: So, you know, clearly that's not a success path. And I don't believe any of our licensees have got significant amounts of spare strainers on hand they have paid to be built just in case they need to add even more. I could be wrong, but I doubt that many of them have done that.

CHAIRMAN WALLIS: At one point the question was raised about maybe having to take some out because there will be too much bypass or too big a strainer.

MR. SCOTT: I had not heard of that being a consideration.

CHAIRMAN WALLIS: This was raised by the industry. Absolutely.

MR. SCOTT: Okay. Well, maybe John Butler can update us on anything that he knows on that.

CHAIRMAN WALLIS: That viewpoint has changed.

MR. SCOTT: Could be. Could be. In any

event, there are a lot of possible approaches to deal with these potentially not good results. One thing -- and you will hear about this today -- is that the industry is, so to speak, sharpening their pencil on some of the conservatisms in the analyses.

And so that may be something that the ones who are most affected by high fiber loadings might plan to do because we do know that a number of the -- for example, the chemical effects topical report is quite conservative. So there are various options.

I agree with what you were implying, that I doubt that they are going to go back and make significant changes to their already changed strainers.

Slide 10. This is my last slide. You had asked about plans for meeting with you all. The question always comes up, are we looking for a letter? For this meeting, we don't have any particular need for a letter at this point.

Of course, if you are interested in sharing your views on our progress, we are always glad to hear those. We don't have a particular regulatory requirement at this point that calls for a letter.

We know that the Commission believes that you all need to stay thoroughly involved in this issue. So however you wish to play that is fine with us.

PARTICIPANT: I think we were planning to address this in the July meeting.

CHAIRMAN WALLIS: You are going to present to the full Committee in July. That's true?

MR. SCOTT: That's fine. That's fine. I assume. I didn't know. Three's no meeting in June, I guess.

PARTICIPANT: There is. Graham is going to be on holiday.

MR. SCOTT: He wouldn't want to miss this. Okay. Okay. Absolutely. Okay. Well, then that's fine. I didn't have that down here. I considered that to be part and parcel of this meeting.

In any event, we planned to come back to talk to you in the fall. There was going to be a lot of new information in the fall, for example.

CHAIRMAN WALLIS: A letter might help if it indicated to you what we would be looking for in the fall.

MR. SCOTT: That's fine.

CHAIRMAN WALLIS: It would be helpful of some things that we needed to bring to your attention that we're really going to look for.

MR. SCOTT: Of course.

CHAIRMAN WALLIS: Then we might want to put it on paper.

MR. SCOTT: That's fine. That's fine. In any event, we would anticipate in the fall that we will be able to talk to you about the in-vessel topical report. Depending on when in the fall we actually brief you, we might be close to done with the review of that document.

Just for your information, we target trying to be at least at a draft SER in about the end of September.

CHAIRMAN WALLIS: When would this be? I think we're going to have a meeting in Germany in October or something on this.

MR. SCOTT: We're willing to go to Germany to meet with you, no problem.

CHAIRMAN WALLIS: So are you going to present before that meeting so we can go over there and tell them what you are doing?

MR. SCOTT: Well, you don't meet in August, right?

PARTICIPANT: We have enough meetings in August.

MR. SCOTT: The full committee doesn't

meet in August.

CHAIRMAN WALLIS: Yes.

MR. SCOTT: If we come in in August and talk about in-vessel, I think it may be a little bit premature.

CHAIRMAN WALLIS: How about September? Well, you can work it out with Zena.

MR. SCOTT: Okay.

MS. ABDULLAHI: Yes. We will work it out later.

MR. SCOTT: That's fine. Anyhow, we will talk to you about that. We will plan to present to you the results of the review that I was mentioning to you about the remaining technical questions. That would be the peer review comments and the staff technical questions. We will talk to you about those.

We hope to be able to persuade the industry to talk to you about results of integrated head loss and chemical effects testing, some of which, a significant amount of which, should be available by the fall. That would be for them to do. And hopefully they would be willing to do that.

CHAIRMAN WALLIS: Now, is this all going to be proprietary or is it going to be open, this --

MR. SCOTT: I would say -- well, let's

see. The in-vessel is proprietary, right? No?

MR. DINGLER: (Inaudible.)

MR. SCOTT: Okay. So the in-vessel topical report is a proprietary document. I guess Moe Dingler was saying maybe we could have an open meeting about it. But it is a proprietary document.

CHAIRMAN WALLIS: The results of integrated head loss chemical effects, is all of that going to be proprietary?

MR. SCOTT: I doubt it because that is licensee testing. They're sponsoring it. You know, they need to share it with us. And their licensing basis will be public record.

CHAIRMAN WALLIS: This will be in the public document room and somebody else other than us can look at it and reach conclusions?

MR. SCOTT: That would be my conclusion regarding not so much the topical report but the testing results and so on, yes.

CHAIRMAN WALLIS: So that they have to stand up not only to ACRS questioning and staff questioning but the public view as well?

MR. SCOTT: Well, as is always true for licensees' compliance, that is true.

CHAIRMAN WALLIS: Well, that is important.

MR. SCOTT: Yes, that's correct.

CHAIRMAN WALLIS: You don't want somebody else to look at them and raise some question that we forgot to raise.

MR. SCOTT: No, absolutely not. The other thing -- so we would plan to talk to you about that in the fall. And there would probably be some other things. And maybe if there is something, in particular, you have an interest in, we can talk to you about it at that time.

And then in the spring, we will be talking to you hopefully about our initial reviews of the generic letter responses and the final audit results because, as I said the last --

CHAIRMAN WALLIS: (Inaudible.) where somebody said GSI-191 is over and done with, finished, buried?

MR. SCOTT: Yes. There are two. Actually, it's more or less parallel processes we go through here. We've got one to close out the generic letter and the other to close out the generic safety issue.

And I've got an integrated schedule that shows that stuff happening. And it's out in the summer and early fall of next year because what happens is we finish up our last audit in January. And we're planning to do a non-trivial review of the generic letter responses. So that's going to take some time.

Again, what we're wrestling with is what is the right level of detail of the information to be provided in the generic letter responses. But whatever it is, it's going to be enough that the staff is going to need to spend some resources reviewing it.

So we see that playing out in the spring and the summer. The regions will be doing inspections of the installations that the licensees have made to verify on each plant that the licensee has put in what they committed to put in in their solutions and their corrective actions.

So we take the audit results. We take the generic letter responses. We take the inspection results. We integrate all of that. And that turns into internal documentation that hopefully will support closure of the issue and closure of the generic letter.

CHAIRMAN WALLIS: And who signs off on it?

MR. SCOTT: The generic letter is closed out inside NRR. And I honestly don't remember. It's a memo from somebody to somebody. And I'm sure that

Mr. Dyer (Phonetic.) will have his final say in it. Whether he actually signs off on it I don't recall.

The generic safety issue process involves additional consideration of review in the generic issues program and research, but it's a similar process. And, like I say, all that plays out next summer and fall the way it is currently looking.

CHAIRMAN WALLIS: Do we have to comment? Are we required to comment on the closure issue?

MR. SCOTT: You're not required to comment on the generic letter process. I believe there is a spot in the GSI process for you all to comment. And we will certainly seek your comments.

That concludes my prepared remarks.

CHAIRMAN WALLIS: Recall a time when we write a letter which says GSI-191 should be closed or should not be closed.

MR. SCOTT: I believe that time will come. And I believe that time will be the middle of next year.

If you all have no other questions, I believe we have the PWR owners' group on chemical effects.

CHAIRMAN WALLIS: Yes. We would like to move along to that. Thank you, Mike, very much.

MR. SCOTT: Thank you.

CHAIRMAN WALLIS: We took a little longer, but I think it was worthwhile. Thank you.

MR. SCOTT: Thank you.

CHAIRMAN WALLIS: We are doing WCAP. Do we have some slides?

MR. REID: You should have them in your --

CHAIRMAN WALLIS: In the book?

MR. REID: -- first handout called "Chemical."

CHAIRMAN WALLIS: We're all ears.

2.A. CHEMICAL EFFECTS - WCAP 16530 STATUS

MR. REID: Very good. I'm Rick Reid with Westinghouse. Today I am going to discuss the pressurized water reactor owners' group chemical model that was presented in WCAP 16530.

Next slide. By way of introduction, the issue is chemical interactions between sump materials and chemical additives to the sump by post-LOCA. And the key interaction we are interested in is generation of precipitates that may cause head loss to the sump strainers.

The approach we have taken --

CHAIRMAN WALLIS: Excuse me. These precipitates also if they go through would go to the core perhaps.

MR. REID: That would be correct, yes. And the approach we have taken to a resolution is first using the NRC-sponsored IECT program results and follow-on testing sponsored by the PWROG to identify the key interactions and to elucidate the factors that control these interactions.

Next slide. Okay. The background here is, as I mentioned, the IECT program chemical effects kind of bled into the design of the test program that we did. We wanted to augment the information that was generated during that program.

For integrated testing, we used typical plant materials, typical loadings, and some chemistries, the five tests, long-term tests, 30 days integrated with the materials in the solutions in the test rate. We used a static temperature of 140 degrees to represent the kind of long-term equilibrium conditions in the sump.

Next slide.

PARTICIPANT: How did you choose these slides that (Inaudible.)?

MR. REID: I believe that IECT program was the NRC-sponsored test.

PARTICIPANT: Right.

MR. REID: And I believe those are selected to kind of bound the plants in terms of sump chemistry primarily and then sump materials but primarily sump chemistry, so different buffering agents and pH values based on --

CHAIRMAN WALLIS: Material. They have these plates at various materials.

PARTICIPANT: You are talking about the IECT?

CHAIRMAN WALLIS: IECT.

MR. REID: Yes, that's correct, IECT program.

PARTICIPANT: Okay. Okay.

MR. REID: That's correct.

PARTICIPANT: Okay.

MR. REID: Okay? And the research I discuss IECT is that it was very important into the development of this chemical model. We obviously didn't ignore the results of that testing.

The PWR program, we did want to augment the IECT program results to understand in more detail some of the important interactions. So we did bench-scale testing of individual materials over a range of temperatures from 195 to 265 degrees Fahrenheit and a range of pH values from 4.1 to a maximum of 12.

And we tested 11 different materials by classifications of materials. And we did precipitation tests at 80 degrees Fahrenheit to determine what precipitates would form.

The ultimate goal was to develop a generic chemical model to predict the quantity and types of precipitates that would be generated under varying plant conditions.

This work included a design of a particulate generator so that licensees and vendors could develop chemical surrogates they could use in chemical-type testing of the strainers.

MEMBER BANERJEE: When you mean the generic chemical model, this is sort of an empirical model or is it based on thermodynamics?

MR. REID: There are some thermodynamic inputs into the model, but the model was based on the results of bench-scale testing, where we used measured dissolution rates of the materials under various conditions as generic and in the sense that it will cover the range of pH values, buffering agents, and temperature values that would be experienced in some post-LOCA in all 69 plants.

MEMBER BANERJEE: So is somebody going to tell us about this model or --

MR. REID: Yes, I will. Yes, I will.

CHAIRMAN WALLIS: Now, this WCAP, I thought I reviewed a draft of this about a year ago. Is this the same thing or is this a new one? It's a different document?

MR. REID: No, sir. It's the same one.

CHAIRMAN WALLIS: The same?

MR. REID: Yes.

CHAIRMAN WALLIS: Has it changed since then? A long time ago I think I saw it drop.

PARTICIPANT: The only change is RAIs and stuff we have had from the staff.

CHAIRMAN WALLIS: So it hasn't changed substantially since then?

PARTICIPANT: Not to my knowledge, no.

MR. REID: As I mentioned, the result of the test and the chemical model were --

CHAIRMAN WALLIS: Excuse me. Then it's now formally published, is it, or is it still --

MR. REID: We're in the last round of RAIs.

CHAIRMAN WALLIS: So it doesn't exist yet as a document officially?

PARTICIPANT: It's officially submitted to the NRC. And I think they got it posted on ADAMS. (Inaudible.)

PARTICIPANT: (Inaudible.)

MR. REID: The testing parameters in the bench-scale testing, as I mentioned, the high temperature we tested was 265 degrees Fahrenheit, low temperature 190 degrees for dissolution testing, precipitation testing 80 degrees Fahrenheit. The pH range was from 4.1 to 12. And the containment materials, we used a selection of representative materials based on plant survey responses.

Next slide. This slide is a little bit (Inaudible.) obviously that the -- this is the classification of the materials. We surveyed the materials, looked at their basic chemical constituents to classify the materials into 11 classifications. And they're given in this slide here.

Now, this is merely a picture of the materials that we tested.

Next slide.

CHAIRMAN WALLIS: When you said, "Representative material: None," that means that you did not test that material? Is that what it means?

PARTICIPANT: Slide 7.

CHAIRMAN WALLIS: And you have listed

materials in slide 7.

MR. REID: That is --

CHAIRMAN WALLIS: But there are none on the -- that means you did not include any of those materials in your tests?

MR. REID: That is correct. Based on previous information included in the IECT program results, we determined that these materials would not be of significant contribution to the chemical species.

CHAIRMAN WALLIS: So if there were significant oil leaks somewhere, that wouldn't have been tested by you if there were a significant oil leak somewhere in the containment?

MR. REID: That is correct in the --

CHAIRMAN WALLIS: It might contribute something, but you didn't test oils that --

MR. REID: That is correct.

MEMBER BANERJEE: What about that (Inaudible.) that lies around? I read somewhere that (Inaudible.).

CHAIRMAN WALLIS: Blue jean fragments and things, blue jean fibers.

PARTICIPANT: (Inaudible.) in one of these reports.

PARTICIPANT: Yes. Those materials weren't specifically characterized and tested in a test program. But, for example, materials such as sand we tested a variety of different silicates material that could be represented by those materials.

PARTICIPANT: Perhaps some subset of the debris (Inaudible.)

PARTICIPANT: Yes. I believe a subset of that debris would be covered by some of the materials that we did test, but we did not specifically --

PARTICIPANT: (Inaudible.) and things like that that seem prevalent.

PARTICIPANT: That's correct.

PARTICIPANT: Yes. Did that have any effect?

PARTICIPANT: Well, I believe it would certainly have an effect on physical head loss. The contribution to the overall chemical effects, I believe it would be minor compared to the other containment --

CHAIRMAN WALLIS: Well, I think in the sort of specifications for the screen, usually the plant has something about this, whatever they call it, residual debris or something like that.

PARTICIPANT: Yes. (Inaudible.) Latent

debris.

CHAIRMAN WALLIS: Latent.

PARTICIPANT: We have all estimated it --

CHAIRMAN WALLIS: Right.

PARTICIPANT: -- so many pounds, 100 pounds, 200 pounds, whatever. And we have to make sure our containments are clean to maintain that margin or whatever we have in there. So periodically most utilities are now doing better cleanliness in the containments to maintain that.

PARTICIPANT: And so these 100-odd pounds which (Inaudible.) you don't expect they would have any chemical effects?

MR. REID: Well, I would believe that the chemical effects of those materials would be minor compared to the effects of the containment materials, particularly insulation materials. Clearly any of the --

PARTICIPANT: Why is that?

MR. REID: Well, any of the inorganic material -- the organic material we wouldn't expect to dissolve and create species that would create precipitates. And that's the concern for chemical effects.

And the contribution of dirt, sand --

PARTICIPANT: You don't think the chemical would make (Inaudible.) things like that?

MR. REID: I do not believe so, no.

PARTICIPANT: You also keep in mind some of the latent debris is a particle that is the fiberglass stuff coming out of the insulation, stuff like that. And there is some PC cost that we do for protective clothing. And that is part of it.

But if my memory proves me right, most of it is the plant debris, the fiberglass, and stuff, insulation type that has already tested is coming out in that and the dirt and the stuff like that. So it's mostly that type of stuff more than the other clothing type and stuff like that.

MR. REID: Okay. This next slide shows the rig that was used for dissolution testing. We inserted the materials in these vessels under various chemistry conditions and temperature conditions and then analyzed the resulting solution for dissolved species and for precipitation.

What we saw was that cal sil and metallic aluminum provided the largest potential for material release into solution.

PARTICIPANT: Were these dirt?

MR. REID: Yes, they were. They were

actually shaken. There was a shaker in that assembly. So they were constantly --

PARTICIPANT: (Inaudible.)

MR. REID: They were constantly shaking during --

PARTICIPANT: And that was (Inaudible.).

MR. REID: No. There was some head space. They were mostly (Inaudible.) but there was some head space.

CHAIRMAN WALLIS: What is MinK made out of?

MR. REID: MinK is a silicate measure.

CHAIRMAN WALLIS: So it is a source of silicon, then, isn't it?

MR. REID: That is correct.

CHAIRMAN WALLIS: And it is very fine particles presumably. It is one of the problems, I believe, with certain filters and screens.

MR. REID: Yes.

CHAIRMAN WALLIS: Because it's fine particles? Is that it?

PARTICIPANT: That's correct.

CHAIRMAN WALLIS: But is this not a chemical effects problem it has? It is essentially a physical effect?

MR. REID: That is a physical effect. The chemical effect comes into the fact that some of that material does dissolve and is released in the solution.

CHAIRMAN WALLIS: So MinK also dissolves to some extent?

MR. REID: That's correct.

MEMBER KRESS: (Inaudible.)

MR. REID: That is correct. We did all of these tests from 195 in part 190 in 265 degrees Fahrenheit and over the range of pH. And they were done in --

MEMBER KRESS: Would you get an (Inaudible.)?

MR. REID: In most cases, we did.

MEMBER KRESS: Which indicated it wasn't mass (Inaudible.).

MR. REID: That's correct.

PARTICIPANT: What was the liquid?

MR. REID: The liquid was a 4,400 ppm boron solution as boric acid with the pH adjusted using sodium hydroxide.

PARTICIPANT: And what is that typical of?

MR. REID: That is typical of the starting conditions of the bounding plant for boron concentration.

CHAIRMAN WALLIS: That's in the sump.

MR. REID: That's correct.

CHAIRMAN WALLIS: While the material is dripping down from the containment, presumably the environment is acidic. It's all boric acid.

MR. REID: That's correct. And the chemical model can take that --

CHAIRMAN WALLIS: Takes that into account?

MR. REID: Yes.

CHAIRMAN WALLIS: So you did test with a low pH, then?

MR. REID: That is correct, yes.

CHAIRMAN WALLIS: With no hydroxide at all.

PARTICIPANT: You went from 4.1 to --

MR. REID: Correct.

CHAIRMAN WALLIS: The dissolution rates were much higher for --

MR. REID: It depends on the material. Actually, for example, for aluminum in the fiberglass materials, dissolution is higher at higher pH. For calcium, it is higher at lower pH.

Yes. I believe that is in here.

PARTICIPANT: I mean, I see the range of

variables.

MR. REID: Actually, I'm sorry. We do not have a test matrix.

PARTICIPANT: So tell me how many tests -- because this is multidimensional. You have got many variables in this program.

MR. REID: That's correct. For each material, we did the minimum of six test runs, so to range at two temperatures and three pH values.

CHAIRMAN WALLIS: And the raw data are in this report?

MR. REID: Yes, they are.

MEMBER KRESS: I was wondering about dissolutions rate. Reading ahead, when you get to total mass, the time involved in getting the total mass, was it some representative time of a LOCA event or what was the time --

MR. REID: In this case the time for most of these tests was short. It was 90 seconds. And the basis for that was that the dissolution behavior is fastest initially in --

MEMBER KRESS: (Inaudible.)

MR. REID: That's correct.

MEMBER KRESS: Getting a maximum rate?

MR. REID: Yes. We wanted to get

instantaneous dissolution rates (Inaudible.).

MEMBER BANERJEE: I'm still trying to understand how from two temperatures you were able to (Inaudible.) behavior.

CHAIRMAN WALLIS: Well, you can (Inaudible.) erraneous behavior pretty easily.

PARTICIPANT: That's for sure.

CHAIRMAN WALLIS: Whether you can conclude that it was erraneous is a different question.

MEMBER KRESS: Yes.

PARTICIPANT: Well, erroneous.

MEMBER BANERJEE: The problem is that typically chemical reactions double in rate every ten degrees.

MR. REID: That's correct. Yes. That's a good -- that's right.

MEMBER BANERJEE: So you did one test at whatever the rate was, 190, and the other at 265. So your rate would have been this is Fahrenheit. So if I translate it into Celsius, divide by 1.8, that would be 75 divided by 1.8. Let's say the --

MEMBER BANERJEE: Do you expect your reaction rate to be up by at least a factor of eight percent?

MR. REID: For a majority of the

materials.

MEMBER BANERJEE: Yes. Is that true?

MR. REID: I believe that was largely true. And then we also did look at the results of the IECT program, which were running 140 degrees Fahrenheit, as a check to our results to see how they matched up.

MEMBER BANERJEE: They should be another factor of 8 lower than your 190.

MR. REID: That's correct.

CHAIRMAN WALLIS: Well, were they measured in rates or were they measured in something closer to an equilibrium? I don't know enough about the test.

MR. REID: We're really measuring rate because they were short-term tests. In IECT? Not really. They were not measuring rates, but what we did was once we had the chemical model developed, we put in the inputs for the conditions for IECT and compared the results.

MEMBER KRESS: In a very circular argument (Inaudible.), your model probably had the (Inaudible.) factor in there. Then you go back and do it. I mean --

MR. REID: No. It didn't assume erraneous behavior.

MEMBER BANERJEE: Then how did you predict what the reaction rate would be?

MR. REID: We didn't predict what the reaction rates would be. What we predicted was the material release of the function of pH and temperature.

MEMBER BANERJEE: Perhaps we should see the model, but it seems to me that the model would have to have some way of predicting that. But whether it was (Inaudible.) reaction-dominant, I would like to understand whether the model is (Inaudible.) or reaction-dominated. If reaction-dominated, it has to have some sort of kinetic model, right?

MR. REID: No. We did not assume a time dependence for the reaction.

MEMBER BANERJEE: Well, you had better (Inaudible.). But let's put this off.

CHAIRMAN WALLIS: Yes. I would like to know about your presentation. Are these 62 slides part of the presentation you are going to cover in the next half-hour or so. Is that --

MR. REID: Well, the intention was to have the detail in here.

CHAIRMAN WALLIS: I think once we start asking these questions, we're not going to get through. But it's important that we ask questions, too. So we may be here until 6:00 o'clock or something like that tonight or maybe if Dr. Banerjee starts getting drowsy, we can go on quicker.

(Laughter.)

PARTICIPANT: That will be (Inaudible.).

CHAIRMAN WALLIS: Okay. Let's move on.

PARTICIPANT: Can I just ask a question here? You indicate that these data on page 10 are for 90-second tests. And the aim is to get instantaneous values.

MR. REID: That's correct.

PARTICIPANT: Looking at the picture on page 9, how are these experiments done to terminate the reaction after 90 seconds?

MR. REID: We simply timed the 90 seconds. That's how long we ran the test. And then we transferred the solution from the vessels, out of vessels for analysis.

PARTICIPANT: And you can essentially instantaneously transfer the solution out of the vessel?

MR. REID: That's correct, yes.

PARTICIPANT: Okay. Thank you.

PARTICIPANT: How did you measure the

amounts on the rock? (Inaudible.)

MR. REID: We did both, but the primary measure was the quantity of dissolved material in solutions.

PARTICIPANT: You had a solution and analyzed --

MR. REID: That's correct.

MEMBER BANERJEE: I was hoping that you would come to the model somewhere on this slide, but what I see is that there is no map anywhere except words. Do you have a model which is written down in something that's programmed?

MR. REID: Yes. If we --

MEMBER BANERJEE: Unless I'm missing it?

MR. REID: No.

MEMBER BANERJEE: It's a lot of words.

MR. REID: See, if we move way on into the presentation, if we go to slide 47, for example, there is the type of equation that we have.

MEMBER BANERJEE: I can't read those. What is RR?

MR. REID: This is the release. That is the release rate for the given material. In this specific example, it's aluminum release.

MEMBER BANERJEE: This looks like a curve fit.

MR. REID: It is a curve fit. That is correct. There is no time --

MEMBER BANERJEE: There is no model for --

CHAIRMAN WALLIS: But it's got sudden significant figures on the --

MEMBER BANERJEE: How many data points was this specifically?

MR. REID: That would have been fitted to six data points.

(End of Tape Side A.)

(Beginning of Tape Side B.)

MR. REID: (Tape begins in mid-sentence.) -- the temperatures and pH value.

PARTICIPANT: That would be significant to know.

MEMBER BANERJEE: Each of these data points (Inaudible.).

MR. REID: That is correct.

MEMBER BANERJEE: So if you have temperature and pH --

MR. REID: It's a variable. That's correct.

MEMBER BANERJEE: So you have one of these for each material?

MR. REID: That's correct.

MEMBER BANERJEE: How do you pick the form of the --

MR. REID: The form of the relationship was chosen to give the best fit to the data.

MEMBER BANERJEE: For different materials, there are different forms of data?

MR. REID: That is correct.

CHAIRMAN WALLIS: So there is no theoretical basis for the form of the equation?

MR. REID: That is correct. The theoretical basis is we did (Inaudible.) pH and temperature-dependent and specifically did not include time dependence.

PARTICIPANT: If I were to ask you to put an error bar on any of these graphs, how would you go about doing that?

MR. REID: To do that, we would look at -- in many cases, we did do duplicate rods. So we would use that data to put the error bars on there.

PARTICIPANT: Do you have any of that information here?

MR. REID: Not in this presentation.

PARTICIPANT: In the report?

MR. REID: Where that information is

available, it is in the report, a discussion of --

CHAIRMAN WALLIS: I would think that there is a fair amount of scatter in the results with these sorts of plants.

MR. REID: We did see some scatter, but in comparison to IECT results and other NRC-sponsored testing, we get good agreement with the predictions.

MEMBER BANERJEE: Will these be carefully --

PARTICIPANT: What's the (Inaudible.) if I may ask?

MR. REID: Pardon?

PARTICIPANT: What prediction?

MR. REID: The prediction from our chemical models. We put the specific temperature --

PARTICIPANT: Your model is an empirical fit.

MR. REID: The empirical fit to the release rate is part of the model. And there are other pieces to the model. We take time sets for temperature, pH condition, calculate release rate over each time step, and then also include effects such as common ion effects so that dissolution of materials will flow down as the quantity of dissolved species build up in solution.

CHAIRMAN WALLIS: What is the criterion for acceptance for these models in terms of screen blockage? I mean, are you looking at best estimate value or something with some sort of statistical confidence or what? Are there some requirements?

Does the staff have any idea what it is going to require for sort of confidence in their results here? And that would tell you how much you need to do in terms of looking at uncertainty and so on. Is the staff going to cross that bridge when it gets to it?

And if you start asking for 95 percent confidence or something, you are going to have to have an enormous number of tests. You can't set an afterthought and say, "We are going to ask for 95 percent confidence" if the experimental basis isn't there.

MEMBER BANERJEE: These tests are relatively (Inaudible.).

PARTICIPANT: All plants (Inaudible.) are. We can discuss that maybe in some more detail in the next presentation that follows, but we will not be asking for a 95 percent confidence. I think we recognize there will be a fair amount of scatter in any type of test, such as these.

The overall objective is to ensure that the model and how the licensees implement it predicts a conservative amount of precipitation and that when integrated head loss testing is performed, chemical effects are handled in a conservative manner.

CHAIRMAN WALLIS: Well, if you have got an equation, like LOG(RR) equals all this stuff, is that a conservative equation? It looks to me like the curve fits three or four data points.

PARTICIPANT: In the following presentation, we will get into more detail about some of the conservatisms we think are in the model.

CHAIRMAN WALLIS: Okay.

MEMBER BANERJEE: So this is just a dissolution model?

PARTICIPANT: It is --

MEMBER BANERJEE: That equation?

MR. REID: That's correct. It is an instantaneous dissolution model that has been used to calculate dissolution rates of the materials over time. And the time factor is included by calculating the release rate as time step (Inaudible.) time step.

MEMBER BANERJEE: This is instantaneous.

MR. REID: That is correct.

CHAIRMAN WALLIS: The sump is active for

hours.

MR. REID: That is correct. That's why the equation is a part of the model. And, as I mentioned, they are calculated at time steps.

CHAIRMAN WALLIS: There is stuff in the sump. And when various chemicals start to get formed, they change the reaction rate of the other chemicals.

MR. REID: That's correct.

CHAIRMAN WALLIS: I'm not sure how these ideal tests are -- you just have one liquid dissolved in one solid here, how that is translated to what happens in a sump when you have many constituents interacting.

MR. REID: That is correct. And I do have a discussion of those interactions and how those were handled in the chemical modeling.

CHAIRMAN WALLIS: Because I think at Argonne, there were some inhibitions of certain dissolutions of materials --

MR. REID: That's correct.

CHAIRMAN WALLIS: -- when some other material was there.

MR. REID: That's correct.

MEMBER BANERJEE: (Inaudible.) describe the chemical model?

MR. REID: Yes. This describes the details of the chemical model.

MEMBER BANERJEE: Do you have all of the equations there?

MR. REID: All of the equations are in the report. And how those equations are applied are in the report. And discussion of the types of interactions that you mentioned and how those were handled in the chemical model are in the report.

MEMBER BANERJEE: So tell me in broad terms the dissolution (Inaudible.).

MR. REID: That's correct.

MEMBER BANERJEE: More common than (Inaudible.). So this loads up the solution (Inaudible.).

MR. REID: That's correct. And then we did precipitation testing and used results of that testing, results of IECT, and the results of literary interpretation that were available to determine the types of precipitates that were --

MEMBER BANERJEE: But that was based on taking the solution now and doing something to make it (Inaudible.).

MR. REID: That's correct. Part of the test program was after these solutions were generated from the individual materials to combine those materials to determine what was precipitates. We used that information, as I mentioned, with other available information to assign the type of precipitates that would generate.

So as the model predicts the quantity of materials and solution and then predicts the quantity of precipitates that would be generated. For example, if you have aluminum and silicon in solution, the model is going to predict you are going to get sodium aluminum silicate precipitate.

MEMBER BANERJEE: Well, let's get this clear in my head anyway. You have got an instantaneous dissolution model, which you run in a transient calculation, right?

MR. REID: Correct.

MEMBER BANERJEE: And, therefore, you determine the concentrations in the fluid?

MR. REID: That's correct.

MEMBER BANERJEE: Then you apply some empirical precipitation model --

MR. REID: That's correct.

MEMBER BANERJEE: -- and see what comes out?

MR. REID: That's correct.

MEMBER BANERJEE: And there are basically two empirical fits. Precipitation is an empirical fit, and this is an empirical fit.

MR. REID: That's correct.

MEMBER BANERJEE: And how many data points? Because all these different materials are there, for the dissolution, you are using six data points?

MR. REID: That's correct.

MEMBER BANERJEE: And what about for the precipitation?

MR. REID: For the precipitation, we looked at results of IECT, as I mentioned, and other literature information on both the thermodynamic evaluations and some kinetic information that is available to determine the types of materials that would expect to be precipitate if you had various species in solution.

MEMBER BANERJEE: Well, are you going to discuss that model?

MR. REID: Yes.

MEMBER BANERJEE: Okay.

CHAIRMAN WALLIS: Well, while we are still looking at slide 10, you have a gram of some sort of aluminum dissolved at pH of 12 and 90 seconds. Is that what it says?

MR. REID: That's correct.

CHAIRMAN WALLIS: So if I run it for an hour and a half, which is 60 times as much or something like that, will I get 60 grams?

MR. REID: We did run some of these tests for longer periods. And we did look at literature value for aluminum release measured at different time scales.

And the answer to your question is at high pH and high temperature, you will likely get something approaching 60 seconds. So there is no --

CHAIRMAN WALLIS: So this is what you recommend, then, and use them. And this is going to lead to equations for use in a sump.

MR. REID: That's correct.

CHAIRMAN WALLIS: And then you are going to extrapolate the 90-second tests to as long as the sump has a condition something like that?

MR. REID: That is correct, and that is one of the --

CHAIRMAN WALLIS: It keeps on dissolving aluminum all that time?

PARTICIPANT: That is one of the conservatisms in the model and the --

MR. KLEIN: Paul Klein from NRR.

I would like to offer one clarification. These are up to 90-minute tests, not 90-second tests.

CHAIRMAN WALLIS: I thought you said 90 seconds.

MR. KLEIN: I think he might have misspoke.

CHAIRMAN WALLIS: A 90-minute test?

MR. REID: You're correct. I apologize.

CHAIRMAN WALLIS: That makes a big difference. So you're scheduled to speak here for 45 hours, right?

(Laughter.)

CHAIRMAN WALLIS: Okay. We had better move on.

MR. KLEIN: So we're clear, it's 90 minutes now.

MR. REID: Ninety minutes. I apologize.

CHAIRMAN WALLIS: Okay. Changes everything.

MR. REID: Okay. So, as we mentioned, this does show the release dependence on pH and, as mentioned for aluminum, the higher release for pH. And calcium silicate, for example, is higher release at lower pH.

Precipitation test. We performed precipitation tests, both by adding select chemical solutions together and adding buffering agents to determine phosphate precipitation.

Should I go on? These are the precipitation test results, determine the types of precipitates that we found in this testing. Then we did characterization of the precipitates to determine the types of precipitates that we have and then the settling rate and filtration properties of the precipitates.

The next slide is a photograph of the precipitation settling rate determinations. In these tests, we transferred these solutions directly from the vessels very quickly into a water bath maintained at 80 degrees Fahrenheit and then observed over a 24-hour period for the formation and settling of that precipitate.

CHAIRMAN WALLIS: Now, the effect of precipitate on the screen is very dependent on the structure of the precipitate, which depends very much on how it is made presumably.

MR. REID: That is true up to a point, but some of the testing that we did forming precipitates under a limited number of conditions we did see some small dependence on the short-term tests on the filtration properties.

CHAIRMAN WALLIS: Going back to the Argonne experiment, I mean, Argonne got some high-pressure drop on their screen with material which couldn't even be seen.

MR. REID: Yes. And that is consistent with our test results that --

CHAIRMAN WALLIS: Would you have recorded a precipitate of that type and in these tests, something which couldn't even be seen but, yet, was capable of blocking a screen?

MR. REID: Well, even in the cases where we didn't necessarily see a visible precipitate, we still passed these through filters for filtration testing.

MEMBER BANERJEE: (Inaudible.)

MR. REID: Generally not.

MEMBER BANERJEE: I want (Inaudible.) not really (Inaudible.).

CHAIRMAN WALLIS: What did they call it?

MEMBER BANERJEE: I don't remember. (Inaudible.)

MR. REID: Well, generally without detailed characterization, we term the precipitates amorous or highly hydrated but not necessarily --

MEMBER BANERJEE: (Inaudible.)

MR. REID: Pardon?

MEMBER BANERJEE: (Inaudible.)

MR. REID: No. In most cases these are -- they settled or appeared to be amorphous or highly hydrated. And they settled very slowly and, even at very low concentrations, caused immeasurable head loss over a filter. These pictures that you see here are after 24-hour settling.

Next slide.

CHAIRMAN WALLIS: I don't see anything. That white stuff at the bottom?

PARTICIPANT: (Inaudible.)

CHAIRMAN WALLIS: Okay.

PARTICIPANT: The white stuff at the bottom.

CHAIRMAN WALLIS: Yes.

MEMBER BANERJEE: (Inaudible.) that you basically took the dissolved material that you had from your other step forward and then put something through it at some (Inaudible.).

MR. REID: In some cases. In some cases, we simply transferred the solution into a cooled bath to see just from that solution whether a precipitate formed.

MEMBER BANERJEE: Just by changing the temperature?

MR. REID: Just by changing the temperature. That is correct. And in other cases, we did combine solutions from the different tests to see if a precipitate formed. And in the last of the cases, we added (Inaudible.) phosphate to determine whether a phosphate precipitate formed.

Summary from the bench testing, what we saw was the elements with the largest contribution was calcium aluminum and sorthon. This is consistent with expectations in IECT programs.

The key precipitates that we determined to be formed were sodium aluminum silicates, aluminum oxyhydroxide, and calcium phosphate for plants that use PSP buffers.

So the chemical model development, the inputs to the model are the temperature and pH profiles over the 30-day or longer emission time --

MEMBER BANERJEE: Why do you call it a model? I mean, a model has some time. This is just two sets of empirical fits, no science that I can see unless I'm missing something.

MR. REID: Well, I believe the science and the reason we call it models, we do have some test data that was used to generate dissolution over a range of pH and temperature values.

MEMBER BANERJEE: I think you dignify this with more than it is, really. Basically it's two empirical sets in a little time set calculation. From what I understand, that is all you are doing unless I am getting something wrong. I don't see any science in it.

CHAIRMAN WALLIS: Well, it's not really a model. It's predictive tool, isn't it? I mean, they are going to use this in order to make predictions.

MEMBER BANERJEE: I could have used the neural network and put all this stuff in and whatever, I mean, the same thing.

CHAIRMAN WALLIS: The purpose is to develop something for use, right, isn't it? It's a empirical tool for use in predicting what happens in the sump.

MEMBER BANERJEE: Right.

MR. REID: That's correct.

MEMBER BANERJEE: It's different from taking into account some science and how ions interact. And then there is thermodynamics and things going on. It gives some basis in equilibrium thermodynamics of what --

MR. REID: Well, we did use that information, where available, from previous studies; for example, Oak Ridge studies on the thermodynamic behavior of --

MEMBER BANERJEE: But is that in a so-called model or did you just wave your hands up?

MR. REID: I don't believe we waved our hands. I believe we considered information from a variety of sources.

MEMBER BANERJEE: How is it in your model? How is it put into your model, this information?

MR. REID: That specifically is included in the model and the identification of the precipitates that were formed.

MEMBER BANERJEE: But you have identified the precipitates. It is an empirical fit. You are just saying aluminum oxyhydride is given by this empirical fit. Isn't that where your model -- I haven't seen your model in this --

MR. REID: No. That's the --

MEMBER BANERJEE: You haven't told us what your model is yet.

MR. REID: No. The function in the model or predictive tool if you would rather call it that is once we had determined the materials that are in solutions, then we have to have a way to determine how they will combine to produce precipitates.

And part of the input to that is one of our test results that determines what precipitates form and previous thermodynamic studies and kinetic studies to determine the types of precipitates that would form under the specific chemistry and temperature conditions.

MEMBER BANERJEE: So is there a module there which runs from equilibrium thermodynamics and says, "Oh, yes. Okay. This is going to form now"? Is there something like that there?

MR. REID: That is not included. The specific calculation is not included in the model. The results from those from previous calculations are included in the model by virtue of the fact that we're saying if we have aluminum and silicate in solution, we are going to get 30 aluminum silicate under these conditions.

PARTICIPANT: Then how do you predict the rate of precipitation? I thought that was coming out of your --

PARTICIPANT: We do not. In the original chemical model, we do not calculate a rate of precipitate formation. We assume that 100 percent of the materials that are dissolved are available. And they immediately form a precipitate.

PARTICIPANT: Well, the model that you're talking about, since we look at the amount that has been dissolved --

PARTICIPANT: That's correct.

PARTICIPANT: -- and from that determine that some species would interact when temperatures change below --

PARTICIPANT: No. They all come in and out of solution at any temperature and pH condition (Inaudible.).

PARTICIPANT: All of it comes out.

PARTICIPANT: All of it comes out.

CHAIRMAN WALLIS: What is the bridge from this to this, the sump question? Are you going to specify surrogates for use in the large-scale testing? Is that what the purpose of all of this work is?

PARTICIPANT: That is correct, that we want to develop a tool to predict the quantity of precipitates that would be generated under plant-specific conditions. And then that quantity of material would be added in the sump screen.

CHAIRMAN WALLIS: And then the sump screen testing is no attempt to duplicate your chemical test on a large scale?

PARTICIPANT: That's correct.

CHAIRMAN WALLIS: So the assumption is made that your tests are good enough to specify what they have to throw into the large-scale tests as a precipitate?

PARTICIPANT: That's correct.

PARTICIPANT: Is there any validation of that on a large scale?

PARTICIPANT: I would say the validation once again is on a large scale or larger scale comparison to the IECT program results. As I mentioned, we did use results of that 30-day integrated test and apply our chemical tool to predict the behavior that we would have expected during the IECT test.

PARTICIPANT: Oxidizing test. Was there any new test? I mean, you could always (Inaudible.) empirical model, always. You may not want to. It may happen just by hindsight. Were there any new tests done to validate this model on a large scale?

PARTICIPANT: Large-scale integrated testing? No.

PARTICIPANT: Nothing has been done. So

you are adding this surrogate that is on a little (Inaudible.) experiment? It's a leap of faith to me.

PARTICIPANT: I guess it's a leap of faith effectively to consider that there are a number of conservative functions that went in to development of the model.

PARTICIPANT: Right, right.

PARTICIPANT: And that was done because there is a deal of uncertainty.

PARTICIPANT: If there is so much conservatism, why not just do one large scale or two or three just to make sure that this is truly conservative and happens also in the large scale? These surrogates, I presume what people are doing, they are just dumping this stuff in and hoping for the best. How do we know that that is really what happens in a real test?

PARTICIPANT: Well, certainly -- and I can't speak in detail to hose this model is used by the end users, but for my understanding, most vendors as a first approach would calculate the material that is predicted to be generated over 30 days and dump that material in.

But they also have the option to say that we're going to predict we have this quantity of material after a week, this quantity of material after another week. And neither of that entered the test.

The model doesn't preclude --

PARTICIPANT: I understand more or less what is happening. It seems that it is pretty imprudent to review this on the basis of the tiny little test if this is really what happens in an integrated system.

PARTICIPANT: I would agree in principle that the body of knowledge from this work was the only body of knowledge we had.

PARTICIPANT: There is much more. I mean, there is the IECT test. What else is there?

PARTICIPANT: No. I think the comparison to the IECT test, IECT test is important.

PARTICIPANT: Yes, sure. But it is a very limited body of knowledge. And it seems enormous scale-up, I mean, to go from there to -- you know, we are talking of real reactor systems that actually --

PARTICIPANT: And that's why I believe the NRR certainly --

PARTICIPANT: (Inaudible.) that you should do some large-scale tests to assure that at least these surrogates really work.

CHAIRMAN WALLIS: We'll find out when they don't.

PARTICIPANT: Or we'll find out when they don't. Yes.

CHAIRMAN WALLIS: Well, I think the testing that has been done with the surrogate material, I think that certainly does show that it causes head loss. The question is, are the quantities of the materials right? And our belief by the conservatism and the conservatism approach we took (Inaudible.) tool is that we are conservatively predicting the quantity of material. So --

PARTICIPANT: I think they are even cross-references. It is not only that you are doing this stuff, but where it comes out that matters. If it comes out in the fuel, in the (Inaudible.) effect, that's a very different situation that coming (Inaudible.). Who knows where it is going to come out.

PARTICIPANT: I guess the question is how we are using the model from a -- there are other reports (Inaudible.) how you do the head loss testing, how we evaluated it on the fuel. And that is not part of this program. That's the question.

PARTICIPANT: My question is, has this model been validated on a larger scale? That is really my --

PARTICIPANT: The answer is we didn't feel it was needed at this time.

PARTICIPANT: You didn't feel it was needed. What was the basis of that?

PARTICIPANT: The basis of that was the conservative assumptions that went into settlement of the model.

PARTICIPANT: Yes, but how do we know they were conservative?

PARTICIPANT: I think the comparisons to existing data that we can run this model along the tool on that would predict material release and subsequent precipitation will show in all cases where we have done that evaluation that we get conservative results.

PARTICIPANT: You have never done a larger-scale experiment. You build newer systems that (Inaudible.). You haven't actually mixed all of these things together. How do you know it is conservative? I really --

PARTICIPANT: I guess I'll go again to the comparison of the IECT, which was a larger-scale integrated test, higher quantity.

Pardon?

PARTICIPANT: If you want a dissolution test, I mean, it was a completely different thing. There was no rate case (Inaudible.).

PARTICIPANT: That's correct, but we can --

PARTICIPANT: Rate doesn't process here, right?

PARTICIPANT: But this tool does not consider rate.

PARTICIPANT: I thought you said you were time stepping.

PARTICIPANT: There are time steps that the model -- the dissolution rate, for example, doesn't have that time dependence.

MEMBER KRESS: I would like to return to that. The 90 minutes for those dissolution tests, you don't get a rate out of that? You end up getting a total amount?

PARTICIPANT: We could have gotten a rate out of that, but we did not because we didn't do it --

MEMBER KRESS: What is the saturation effect?

PARTICIPANT: No. We assumed that that dissolution rate would go forever.

CHAIRMAN WALLIS: They are only measuring rate. They think that they are only measuring rate. There are no equilibrium limits or anything, as I understand it.

PARTICIPANT: That is correct.

PARTICIPANT: (Inaudible.) will continue forever.

PARTICIPANT: That's correct. That is one of the conservative assumptions in the model.

PARTICIPANT: (Inaudible.)

CHAIRMAN WALLIS: I suspect the staff is asking all the questions we are asking.

My plan is to let you go to 10:30, which means we are going to be behind by half an hour or 45 minutes or something, but this seems to be an important part of the day's work. And then we'll just try to catch up later, but we're probably going to be running late today.

PARTICIPANT: If the staff is asking these questions and we are just repeating ourselves, then we should know that.

CHAIRMAN WALLIS: Well, the staff is going to come on and reassure us after the break.

PARTICIPANT: Can you reassure us now that you are asking all of these questions?

PARTICIPANT: (Inaudible.) after the

break.

(Laugther.)

CHAIRMAN WALLIS: By the way, there is no court reporter here. Everything you say is being taped. So what do we do? We sell the tapes to the public or what do we do? Do we have to make a transcript?

PARTICIPANT: Yes (Inaudible.).

CHAIRMAN WALLIS: It will be provided into a transcript? And hopefully it will make some sense, then, when it is written down?

PARTICIPANT: (Inaudible.) reminder is for the members not to (Inaudible.).

PARTICIPANT: (Inaudible.) identify.

PARTICIPANT: (Inaudible.)

CHAIRMAN WALLIS: Yes. Okay. So let's press on here because we actually have a lot more material.

PARTICIPANT: And some data, too.

CHAIRMAN WALLIS: Yes, but you are going to finish by 10:30.

MR. REID: Okay. Very good. Okay. So we consider the chemical effects model to be an integrated test model development tool. I don't object to that designation either.

So the factors that we considered are we did use available thermodynamics and kinetics information. We did consider common ion effects. That's an option in the model. Loss of dissolved species to precipitation, we did consider that. Effect of other dissolved species on material release rates, inhibition and catalysis we did consider.

CHAIRMAN WALLIS: Did it work? Was there significant inhibition and catalysis?

MR. REID: Well, what we determined was that there was not significant catalysis to be concerned with with a species that we determined (Inaudible.). Inhibition, there are some significant inhibitions. And they were not included in the original model. We have taken a look at those subsequently. And I will discuss that if we have time.

We did consider system homogeneity as a potential factor, dynamic versus static changes in solution chemistry we considered and dynamic versus static changes in temperature and then, finally, potential effects of oxygen.

CHAIRMAN WALLIS: Now, BWR gets coded with --

MR. REID: That's correct.

CHAIRMAN WALLIS: It sounds to be like a catalyst, a catalytic surface.

MEMBER BANERJEE: Chemical industry would be when finally decided.

CHAIRMAN WALLIS: You don't put them in the PWRs. I'm just thinking of since we're talking about catalysis.

MEMBER BANERJEE: Did any chemical engineer work on this?

MR. REID: Yes. I'm a chemist. And we had chemical engineers working on this as well. The primary developers and primary performers of this work were chemists, but we did have chemical engineers involved in the development and in the program.

MEMBER BANERJEE: At Westinghouse?

MR. REID: At Westinghouse.

MEMBER BANERJEE: Where are they?

PARTICIPANT: I was going to ask you if you have run any experiments where you added two of these materials or even all 11 simultaneously in one reaction chamber.

MR. REID: Not in this test, we did not.

PARTICIPANT: So, in essence, the data that you have assumes that no other material exists?

MR. REID: No. These data were generated

to determine individual material release rates that were not affected by the presence of other material. And then we did an evaluation of the potential interactions.

The interaction of materials after dissolution was determined by adding solution together to determine where precipitates were formed, but as far as material, the effects of dissolution rate on individual material as influenced by the presence of another material, we did that evaluation based on the literature data and IECT program results.

PARTICIPANT: And the result of that evaluation is what?

MR. REID: Well, we determined that we could not identify any cases where one material would enhance the dissolution of another material, but there were cases where presence of one material would inhibit the release of another material.

For example, silicate-containing material would be expected to inhibit the dissolution of aluminum metal.

PARTICIPANT: And you decided that there is no need to do confirmatory experiments? Then these are fairly simple --

MR. REID: In the original model, we did

not elect to take credit for silicate inhibition due to some of the difficulties that could be inherent in applying that inhibition. We have subsequently looked at that in another program, but we did not choose to do that in the original program.

PARTICIPANT: Thank you.

MR. REID: Okay. These next couple of slides --

CHAIRMAN WALLIS: What are the effects of oxygen on the bottom here?

MR. REID: That's correct. We did look at that.

CHAIRMAN WALLIS: CO_2 as well?

MR. REID: Yes. We did subsequently consider the effect of CO_2.

CHAIRMAN WALLIS: Formation of carbonates?

MR. REID: That's correct. And the bottom line, what we determined is the predictive quantities of materials that may combine with CO_2 to product carbonate, if we assume that those react, instead, to produce, for example, hydroxides, the hydroxides cause higher head loss. So it's worth it to have hydroxides in the carbonate.

MEMBER BANERJEE: Now, the peer review committee made some points about effect, directly or indirectly, from the radiation field, did you check any those in response to comments?

MR. REID: We did take a look at those comments. And briefly what we determined was that the radiation effect on these particular materials at the radiation levels that we would expect to be present in the sump would not be significant.

And the basis for that is a lot of these materials; for example, the silicate materials, are present on the course. We have some idea about behavior, dissolution behavior, of these materials in a radiation.

MEMBER BANERJEE: And what about they pointed out things like hydrolysis products (Inaudible.) all these other things that --

MR. REID: Yes. We considered hydrolysis products. And we took a look at the quantities, for example, of peroxide and hydrogen that would be generated and determined that those quantities would be less -- for example, that there's less hydrogen, for example, from radiolysis than there would be from corrosion of aluminum material. And there is less peroxide and subsequently oxygen from solution in radiolysis than there would be simply from the containment atmosphere.

That is, there's PPM, low PPM, levels of hydrogen and peroxide and oxygen generated from radiolysis.

MEMBER BANERJEE: If I remember, you know, you went through the pere review in not that much detail, but (Inaudible.) McDonald has some equilibrium, thermodynamics calculations with some fairly significant effects of radiolysis products. Am I wrong or is my memory serving me wrong? Maybe you can --

MR. REID: I didn't see that data.

MEMBER BANERJEE: It's not data. It was (Inaudible.).

PARTICIPANT: No. You're correct. I think he had done some calculations that estimated the amount of nitric acid that could be formed and indicated by the amount formed, it could change the pH substantially, thereby affecting chemical effects.

Licensees do account for that when they calculate the total amount of buffer that is added to the system. The amount of nitric acid that might be formed after an accident is included so that you don't get wide pH changes, as he calculated.

MEMBER BANERJEE: Oh, I see. Okay. Thank you.

CHAIRMAN WALLIS: So you are going to tell us you have got hundreds of kilograms of material dissolved --

MR. REID: That is correct.

CHAIRMAN WALLIS: -- in some form?

MR. REID: That is correct. And I think that is a demonstration of the conservative nature of the predictive pool. That is, we are based on the assumptions we make, particularly lifetime-dependent and the media formation of precipitates, irrespective of temperature and pH conditions. As considered in the original model, we do predict under many circumstances large quantities of materials that that would --

CHAIRMAN WALLIS: I don't have the numbers, but Argonne got a huge increase in head loss with very small amounts of some of these chemicals.

MR. REID: That's correct.

CHAIRMAN WALLIS: I don't remember the numbers.

PARTICIPANT: That's correct on a vertical head loss test.

CHAIRMAN WALLIS: A very large amount of stuff.

PARTICIPANT: That's correct.

CHAIRMAN WALLIS: Enough to affect a very large screen.

PARTICIPANT: And that's why Mike Scott said that licensees are now --

CHAIRMAN WALLIS: They don't like it.

PARTICIPANT: They don't like it. As a licensee, I don't like it. It's the data that's presented. We're looking at Rick can get into some of the conservatisms. And this one gentleman over here asked the question about interaction with silica and aluminum reduces the corrosion rate, some of that. We have looked at that.

Other plants are looking at reducing the fiber, that we can reduce the amount of generation of byproducts, of chemicals, and that. So we are looking at all of the available toolboxes that we have or tools that we have to reduce some of this amount of generation. And that's --

CHAIRMAN WALLIS: Will we hear later on about broad-scale tests where typical amounts of these materials were thrown in --

PARTICIPANT: I think --

CHAIRMAN WALLIS: -- corresponding to these numbers here or --

PARTICIPANT: In the afternoon today and

into tomorrow, there are four utilities that are going to speak of how we are working with this chemical and how we are reducing some of the area to make sure we pass.

And that is what Mike Scott said, that the chemical effects -- and we are working with the vendors, and you will hear from the vendors of how they're working to refine to come up with a way to do a head loss test with the chemicals.

CHAIRMAN WALLIS: I think what we heard last time we met with the staff, I think it was -- maybe some industry folks were there -- was that some of the large-scale tests where they tried to duplicate these amounts of stuff were just unacceptable. The screen got so blocked that it was unacceptable. Is that the case?

PARTICIPANT: In some areas where you have -- some of the latest tests is if you have open sump screen, it will pass through. If you have high approach velocities, the fiber and the chemicals will compact together and cause you high head loss.

So it's a combination of if you have low-approach velocities, you have a lot of fiber, and how that interacts is going on, and how each vendor, each utility is taking us very plant-specific at this time how to reduce it.

CHAIRMAN WALLIS: If you are conservative and assume a thin bed effect and all of that and all of this stuff, I think things don't look very good for some screens.

PARTICIPANT: That is correct. Some of the screen geometries, you will hear this afternoon and tomorrow that with the new complex dimensions, thin bed may not form. So you have some availabilities in some of that, too.

CHAIRMAN WALLIS: But we will hear about all of that later on?

PARTICIPANT: Yes, later on.

CHAIRMAN WALLIS: Okay.

PARTICIPANT: That is in the individual utilities' presentations. And if you do vertical head loss testing against the integrated test, you will have some results and stuff different in that.

CHAIRMAN WALLIS: What did you say, 600 kilograms of pretty fluffy stuff, isn't it? I mean, it's not --

PARTICIPANT: That's correct.

MR. REID: That's correct.

CHAIRMAN WALLIS: So in terms of volume, if it were not compressed, how many truckloads would it be?

PARTICIPANT: That one I can't do in chemical, but I can tell you that on my --

CHAIRMAN WALLIS: The measure of stuff is how many pickup --

PARTICIPANT: I can give you for Wolf Creek the fiber in tomorrow's presentation. I do have that in fiber.

CHAIRMAN WALLIS: I think 600 kilograms of very fluffy stuff is pretty big volume --

MR. REID: It is.

CHAIRMAN WALLIS: -- in terms of a pickup load. Okay.

MR. REID: Okay. Move on?

CHAIRMAN WALLIS: Yes. Yes, we've got to move on. You are going to be cut off at 10:30. Tell us what is important in all of this.

MR. REID: Okay.

CHAIRMAN WALLIS: We could spend the whole day, I think, on your presentation.

MR. REID: Okay. I think this one is somewhat warranted. So we will discuss this, the particulate generator testing. Part of this program, we did develop what we call a particulate generator. That is, we developed chemical recipes for making surrogate materials that the vendors could use in testing and then set up a rig to develop these precipitates and then tested the resulting precipitates for the prototypicality in representing the behavior of the precipitates we generated during our bench-scale testing.

PARTICIPANT: Dr. Wallis?

CHAIRMAN WALLIS: Has the staff blessed these precipitates and said they are okay to be used?

MR. REID: That is part of the SE. And I guess we will let Paul chime in, but I believe they have.

CHAIRMAN WALLIS: They have blessed them?

MR. KLEIN: They were in the RAI process right now.

MEMBER BANERJEE: You're hoping that --

PARTICIPANT: That's correct.

MR. REID: Yes.

CHAIRMAN WALLIS: Well, let's see how we can evaluate whether their blessing is appropriate or not without much more study. I'm not sure how much time we have. We can't devote the rest of our lives to understanding the chemistry of sumps.

MEMBER BANERJEE: I think it might be useful, at least for me, to review this report in detail.

CHAIRMAN WALLIS: I am just thinking, do we have to have a Subcommittee meeting on this report by itself?

MEMBER BANERJEE: Right. And then just ask questions about things (Inaudible.). And I think it has to be -- does it have to be done on the Subcommittee meeting? I don't know the protocol.

CHAIRMAN WALLIS: See, maybe rather than writing a letter now, we may say we want to write a letter after we have reviewed hits report.

MEMBER BANERJEE: I guess this is an important aspect of the strategy because this allows utilities to use surrogate materials to look at chemical effects.

MR. REID: That's correct. And that approach -- I believe institute generation of these types of precipitates would be very difficult going from the high-temperature, varying pH conditions, and so forth. That would be a very difficult task.

And so the generation of precipitates is important. And we do want those surrogate materials to behave, both in terms of settling rate (Inaudible.) characteristics as closely as possible to the real materials. And we did testing to convince ourselves that that was indeed the case. These materials, even at small concentrations, can cause high head loss. And they do settle relatively slowly, certainly over days, rather than minutes.

MR. SCOTT: Mike Scott, NRR. If I might interject here?

If you all are planning or thinking about doing a detailed review on this report, I would only ask that you do so in the very near future because the staff's reviews is nearing the end on this. So time is of the essence. Thank you.

MEMBER BANERJEE: Maybe you have done all the review that needs to be done, Mike. I mean, we haven't seen your (Inaudible.) or whatever, RAIs, or whatever they are.

MR. SCOTT: And it's not done yet. Paul will, of course, talk to you about the progress on that. We're not at the endpoint. My only point is we are nearing that endpoint in more ways than one.

CHAIRMAN WALLIS: You don't review things until you have don ether SE. And then your SE covers all the points that we are interested in. We say it is fine. We don't try to do your work for you. Had you done your work, then --

MR. SCOTT: Doggone it.

CHAIRMAN WALLIS: -- (Inaudible.) whole thing. That is what we usually do.

MR. SCOTT: Okay. Well, the only trick is that -- let's see. Paul Klein, when is our expected completion of our SE?

MR. KLEIN: September 11th.

MR. SCOTT: September 11th, 2007. So then you're out in the fall. It's just very compressed here. So I would just ask that --

CHAIRMAN WALLIS: Then we can write a letter saying your SE was brilliant and covered all of the important issues.

MR. SCOTT: That would be a very excellent letter for you to write, yes. Thank you.

(Laughter.)

MEMBER BANERJEE: We could look at the report in advance and --

CHAIRMAN WALLIS: Do we have a CD of this report, Zena?

MS. ABDULLAHI: I think so.

CHAIRMAN WALLIS: I think it would be appropriate because I looked at something. I think it was about a year ago. It seems an awful long time ago. I looked at some preliminary version of that.

MR. SCOTT: Well, what you have now is you have the RAIs and shortly -- or we have RAI responses, too. Right? So --

CHAIRMAN WALLIS: That is a struggle to work through all of that.

MR. SCOTT: Yes, but I --

CHAIRMAN WALLIS: I would like to review the final thing.

MEMBER BANERJEE: (Inaudible.) the paper? I mean, can't we just look at the report and fined the 17 pages there --

CHAIRMAN WALLIS: This is the final thing?

MEMBER BANERJEE: -- that you have something in it?

PARTICIPANT: The problem is that unless they revise the report -- and you aren't planning to revise it, are you? So the RAIs and the RAI responses make up, really, the staff's comments and questions and things like that. And without reviewing that, I don't think you have the full picture.

CHAIRMAN WALLIS: The report has to stand on its own, doesn't it?

MR. SCOTT: Well, as I assume they will do this, they will publish the report with the RAIs and the RAI responses.

CHAIRMAN WALLIS: So the utility has to

read all of the RAI responses in order to understand the report?

PARTICIPANT: It depends on the RAIs.

CHAIRMAN WALLIS: That doesn't sound very good.

MEMBER BANERJEE: It's not going to be integrated as part of the report?

PARTICIPANT: Some of the RAIs are clarification questions that may not need to be reported. Some may be some wording changes that we're looking at and see how that incorporates into the WCAP.

MEMBER BANERJEE: How thick is the report?

PARTICIPANT: I can't remember.

PARTICIPANT: A hundred and eighty-three pages, I hear.

MEMBER BANERJEE: How much of that is data?

MR. REID: See, the bulk of that is the data and the test plan, bulk of this --

MEMBER BANERJEE: So you've got raw data there?

MR. REID: That's correct. All of the raw data that was generated is included in the report.

MEMBER BANERJEE: That would be good.

PARTICIPANT: We can provide --

MEMBER BANERJEE: Raw data always works.

PARTICIPANT: Okay. I guess --

PARTICIPANT: I guess, Dr. Wallis and for the members, we are going to jump ahead to theirs. We have done some additional work, as Rick said, to look some of the inhibitions of the chemicals. So we are going to let just Rick speak from them, not necessarily their slides in there, but to go ahead and say what we did. Those are more slides toward the end, 40 in that.

CHAIRMAN WALLIS: Okay. Look at the settling test. It says something about the one-hour settled volume. This presumably is in some standard tube or something?

PARTICIPANT: That's correct. Yes. We wanted --

CHAIRMAN WALLIS: And you say how big the tube has to be and all of that is all specified?

PARTICIPANT: Yes, it is.

CHAIRMAN WALLIS: Okay. Thank you.

MEMBER BANERJEE: So the turbulence actually slows down the --

PARTICIPANT: That's correct.

CHAIRMAN WALLIS:

CHAIRMAN WALLIS: The sump is not completely standard? There is flow going on, isn't there? There is stuff cascading down from above and --

PARTICIPANT: That's correct. So what we wanted to show was that the surrogate material, even under quiescent conditions, would not settle for -- okay.

I will discuss briefly -- as Moe mentioned, the slides start at 36, but we won't look at the slides in detail. What we did following the original model development, we did do some additional testing to look at some of the conservative assumptions that were in the original model. And particularly we looked at the effect of silicate inhibition because we know that that certainly is a potentially big effect.

And what we saw there was based on corrosion rates once we got to about 75 ppm silicon is the corrosion rate for aluminum based on metal loss went down by a factor of at least 11 based on dissolution release of aluminum into solution went by a factor of around 100 less.

So silicate inhibition certainly is a large effect. So that is a tool that can be available to select plants, particularly high-fiber plants, for reducing the amount of aluminum that comes into solution from aluminum metal, which is one of the largest sources of precipitate.

MEMBER BANERJEE: Is it a solution effect or is it a passivating effect? What sort of --

PARTICIPANT: It would be a passivating effect from the formation of aluminum silicate on the surfaces. Another effect we looked at was differences in corrosion rates of aluminum alloys. And our original testing, we followed the IECT program and used commercially pure aluminum as the aluminum metal source for our test.

And recognizing that there is a variety of aluminum alloys in use in plants, we recognize that these could have lower release rates than commercially pure aluminum.

What we determined in our test is that the difference between aluminum alloys wasn't appreciable for the alloys that we tested. At most, we got about a factor of maybe 20 percent reduction in the amount of aluminum release based on different alloys.

The next thing we looked at was phosphate inhibition of aluminum corrosion. We have to recognize the effect by the same --

CHAIRMAN WALLIS: What if the aluminum gets leached out of this alloy? What happens to the rest of the material?

PARTICIPANT: You would have some surface enrichment of the alloy materials, but the alloys are predominantly aluminum.

CHAIRMAN WALLIS: Does it go into solution or does it make a matrix or something?

PARTICIPANT: For the most part, we would detect selective dissolution of aluminum from the alloys.

CHAIRMAN WALLIS: You did the test?

PARTICIPANT: We did the test, but we only looked at aluminum. And, as I said --

CHAIRMAN WALLIS: You only looked at aluminum.

PARTICIPANT: As I said, what we really determined was that the mass loss of aluminum, of the aluminum coupons, was not that difference from commercial to pure aluminum. That is the effect that offers negligible benefits.

MEMBER BANERJEE: So aluminum is always present if you're talking about surface effect? In reality, the aluminum is always present so that (Inaudible.) surface or not?

PARTICIPANT: Yes. The exposed aluminum metal, yes, that is the expectation that that surface would be available for formation of aluminum silicate.

MEMBER BANERJEE: That is typical (Inaudible.) aluminum should be in the past or --

PARTICIPANT: Yes. For the aluminum metal, that was -- we only applied this for aluminum metal. There are other sources of aluminum. For example, insulation materials do have aluminum silicate. And concrete has an aluminum component.

We did not consider inhibition of aluminum from those sources, only from aluminum metal.

MEMBER BANERJEE: Only like large (Inaudible.) structures, not a very porous substance.

PARTICIPANT: Correct, yes.

PARTICIPANT: In the cases where you calculate hundreds of kilograms of dissolved, does that represent -- what fraction of the total inventory are we talking about? Percent? Tenth of a percent?

PARTICIPANT: In most cases, we have thick metal. It is a fraction of the material available. But the model does --

PARTICIPANT: Just give me an order of magnitude when you say, "fraction."

PARTICIPANT: I apologize. I don't have

a number right off the top of my head. For aluminum metal, I would have to guess, but I would say less than five percent. But materials like insulation, particularly calcium silicate, essentially all of that material is predicted to dissolve.

CHAIRMAN WALLIS: It depends on the plant. There is only one plant, I think, that has a huge amount of aluminum.

PARTICIPANT: That's correct.

CHAIRMAN WALLIS: It depends very much on the plant site.

PARTICIPANT: But it's a circus phenomenon.

PARTICIPANT: That's correct.

PARTICIPANT: So it depends on how thick that material is. And I want to get an idea of whether we're talking about a tenth of a percent of the total or --

CHAIRMAN WALLIS: Can you climb the ladder after it has been in the sump for a while? I mean, does it dissolve completely or just a tiny little bit of it?

PARTICIPANT: I can't answer that question immediately.

PARTICIPANT: Based on the mass lost from the IECT and that, there wasn't that much loss. It was very proportionate based on the IECT and the integrated in some of the stuff we did or Westinghouse did that the structure --

CHAIRMAN WALLIS: How does it get in the sump anyway? Isn't it up above somewhere? Is it actually in the --

PARTICIPANT: Most of the corrosion --

PARTICIPANT: It depends. It's plant-specific. Some may have aluminum scaffolding they want to remove from the flood area. So plants are looking about removing their aluminum. Some may have some junction boxes and that they're looking at.

Again, it's very plant-specific of where that aluminum is. And I can't speak for those plants at this point.

PARTICIPANT: (Inaudible.) some of the aluminum was (Inaudible.).

PARTICIPANT: Correct.

PARTICIPANT: And that's what would be inhibited by (Inaudible.).

PARTICIPANT: The material in the spray would also be inhibited provided there are suspicions of silicon in the spray. And the basis for saying that is silicate is used to form conversion codings on metal species and spray applications of conversion codings, such as silicates and phosphates, is an industry practice.

CHAIRMAN WALLIS: So we are going to stop at 10:30. I don't know what you are going to do to get through here.

MR. REID: I believe I am just about done. I wanted to talk about --

CHAIRMAN WALLIS: Emphasize anything in particular?

MR. REID: I did. Phosphate inhibition I will mention quickly. We did take a look at phosphate inhibition of aluminum corrosion. Then we found a positive effect there.

And then, lastly, we are looking at solubility behavior of these precipitates because, as we mentioned, the original model conservatively assumes that if the species are available in solution, they will immediately form a precipitate, irrespective of temperature and pH conditions. And we recognize that that is not he true physical case.

We did want to examine solubility behavior of these species as a function of temperature and pH. And what we found in that testing was that sodium aluminum silicate does seem to precipitate, essentially irrespective of temperature and pH under equilibrium conditions, aluminum oxyhydroxide. There is a solubility limit.

So you can have some aluminum in solution and not precipitate aluminum oxyhydroxide at higher temperatures. And then, finally, calcium phosphate, which is our other key precipitate, seems to precipitate essentially immediately, irrespective of temperature and pH conditions.

CHAIRMAN WALLIS: I think what we might be very interested in when all of this is summed up is what exactly you recommend as the recipes for use by the plants. We won't get to that today, but I guess that's what I'm really interested in. And what is the basis for those recipes?

PARTICIPANT: And that will be in the WCAP.

MEMBER BANERJEE: I guess the bottom line here is that whatever you suggest (Inaudible.). To me I still feel a little bit uncomfortable with, one, I understand that you cannot easily do large-scale tests where you have typical pH tests, things like that. You can't do it routinely.

But it would be nice if one test were done to show that (Inaudible.). You are doing little tests in this case, lots of surprises. Chemical reactors (Inaudible.) tiny little experiments (Inaudible.) later, but there is a scaling effect there.

So how do we know (Inaudible.) similar effects (Inaudible.)? Something unexpected (Inaudible.) come out where you expect it to. They come out always in the worst part, --

MR. REID: Right.

MEMBER BANERJEE: -- something like that.

MR. REID: Right. Well, in brief answer to that, again I'll say that, yes, we did look at all available data from all previous and related testing, open literature, data, and we did consider potential interactions. And we used our best engineering judgment.

CHAIRMAN WALLIS: Okay. Are we ready to take a break now? Do you have a final word for us? I'm going to take a break. You're going to be around for the rest of the day and tomorrow so we can get back to you?

MR. REID: At least the rest of the day. Yes, sir.

CHAIRMAN WALLIS: If there's something that you needed to tell us that you didn't get to say, then maybe there will be an opportunity later. I don't want to miss anything important. Okay?

We will take a break for 15 minutes. And then I think the reporting will begin. So will you be ready to go after the break? Yes. Okay. Then we will be on the court reporting. We will take a break until quarter to 11:00.

(Whereupon, the foregoing matter went off the record at 10:34 a.m. and went back on the record at 10:50 a.m.)

CHAIRMAN WALLIS: We're looking forward to the next presentation by Paul Klein from NRC, who will also address the matter of chemical effects. Please go ahead.

MR. KLEIN: Thank you and good morning.

2.B. CHEMICAL EFFECTS - NRR STAFF PERSPECTIVE

MR. KLEIN: I'm Paul Klein from the Office of Nuclear Reactor Regulation.

And if I could have slide 2? Thank you. The primary objective of this presentation is to provide the NRC staff perspective regarding the chemical effects methodology that is contained in WCAP-16530. It was discussed during the last presentation. I also felt it was important to describe the NRC's regulatory path forward in the chemical effects area.

Slide 3, please. By way of status, I think that the Subcommittee should understand the staff review of WCAP-16530 is still work in progress. Therefore, I will not be providing conclusions concerning the NRC staff evaluation of the WCAP at this point. However, I think we can offer some opinions that will provide insight into some of the staff thoughts.

CHAIRMAN WALLIS: This has been a concern of mine all along is we always seem to have work in progress. And what I want to avoid is you having a schedule where you suddenly give us a lot of stuff and we review it and we give you our input, which delays things. We don't want that to happen.

If all this stuff keeps being in progress, it is very difficult for us to input to it.

MR. KLEIN: You heard in the last presentation our scheduled delivery date for an SE on the WCAP. And we intend to meet that.

CHAIRMAN WALLIS: But if we have really strong questions about it, then I think you need to know pretty soon.

MR. KLEIN: And I think we can discuss that during this presentation. Just to give you some idea of the WCAP, the topics contained in it are broad. And the staff receives some assistance in the technical evaluation of the WCAP. And I want to acknowledge that we have had input provided by both Argonne National Lab and a member of the chemical effects peer review panel.

In addition to some of the technical assistance we received thus far in evaluating the WCAP, we also requested a couple of different sets of tests be performed in order for us to help evaluate some of the WCAP tests that were done and some of the assumptions that were made. And we will discuss those in more detail in a few slides.

But, in particular, we asked ANL to evaluate preparation of the WCAP surrogate and also to evaluate its head loss performance relative to some of the precipitate that they tested in their earlier head loss program.

MEMBER BANERJEE: We heard that, didn't we?

MR. KLEIN: Yes. The Subcommittee did hear in February a summary of that head loss test. And then an additional thing, we had requested some additional supplementary leaching tests performed at Southwest Research Institute. And we will go into those in a little more detail as well.

CHAIRMAN WALLIS: What wasn't clear to me, I mean, sort of the ANL stuff, was what is it that you folks are going to accept as being appropriate for design and evaluation of these screens. And we didn't really get to that point at all.

MR. KLEIN: We can discuss that now or in a couple of slides.

CHAIRMAN WALLIS: When it is in your time. But it always seems to be that new information coming in, we didn't see how it was all going to be put together in a final recipe for making decisions.

MR. KLEIN: And I think that is a very good point. One of the challenges that the staff faces here is that this is very much an evolving issue and that the industry approach has changed over time.

There was an initial approach based on the base model WCAP. As you can see, it predicts a large amount of precipitate. The initial integrated head loss tests that were performed did not meet head loss criteria.

So it's caused a reassessment in the industry. And the staff is reacting to that as well. But at this point we have issued --

MEMBER BANERJEE: Have we heard from the Southwest Research Institute? I don't recall.

MR. KLEIN: No, I don't believe that the Subcommittee has been briefed on that. And this is a very limited-scope effort, I should add. In this case, what happened was we had some money that was allocated for evaluating thermodynamic models.

And it became clear at some point to the staff that the current commercially available models would not be able to be developed to a point where there would be a useful predictive tool. We used some of that leftover money to perform some tests.

MEMBER BANERJEE: Yes. We did hear something about that.

MR. KLEIN: Yes, but you had not heard about the leaching tests.

CHAIRMAN WALLIS: So they're not going to be used?

MR. KLEIN: The thermodynamic models from our perspective will not be used as a predictive tool.

So, just to finish off this slide, there have been two sets of RAIs.

MR. TREGONING: I'm sorry to interrupt. Rob Tregoning, Office of Research.

I just wanted to clarify. We did brief you on the thermodynamic research.

CHAIRMAN WALLIS: Right.

MR. TREGONING: The subsequent leaching test results we did not brief you on, but we did provide you with those reports along with a stack of other NUREG reports that you have been given. So we haven't specifically briefed on those, but it's a letter report that we received from CNWRA. So you do have those results.

MR. KLEIN: Thank you, Rob.

We have received responses to both sets of RAIs. The latest response from the owners' group came in to the agency in April. And we're projecting an SE for late summer time frame.

Slide 4. I don't intend to discuss in detail the WCAP model, but I will try to add some perspective to the model and how its development is implemented in subsequent integrated head loss testing.

If you look at the WCAP model as a whole, there are probably two main pieces that you can divide it into: development of the chemical model or predictive tool. And then the second part is the actual preparation of surrogate precipitate that is ultimately implemented in subsequent head loss testing by individual strainer vendors.

MEMBER BANERJEE: The Argonne tests, they used typical surrogates, right, in this report?

MR. KLEIN: The ANL follow-on tests that I will describe here used the WCAP surrogate prepared as recommended within the WCAP.

CHAIRMAN WALLIS: Didn't they also make some in the loop itself?

MR. KLEIN: Yes. The ANL head loss program was made in the loop for the most part.

MEMBER BANERJEE: Well, we heard I thought also something about surrogates as well as made in the loop. They had already been reported to us or when they reported to us, I remember that there was something on surrogates.

MR. KLEIN: That's correct. And I will get to that in one slide.

MEMBER BANERJEE: Okay.

CHAIRMAN WALLIS: Well, the bottom line seemed to be as soon as you put some in, the stream plug --

MEMBER BANERJEE: It was a large effect.

MR. KLEIN: Yes. So I'm still on slide 4 here. Within the development tool that they had to predict how much precipitate forms, you heard Rick Reid describe earlier some of the dissolution tests, some of the precipitation tests. Ultimately their spreadsheet predicts a total amount that is not based on the precipitation testing. It's based on how much material goes into solution. And then all of that material is presumed to precipitate.

CHAIRMAN WALLIS: By it presumes a precipitate, you mean it becomes particulate matter which can accumulate on the screen because precipitate to some people means it settles down in --

MR. KLEIN: No. It becomes an amorphous precipitate that's hydrated that has --

CHAIRMAN WALLIS: Which could be available to deposit on the screen?

MR. KLEIN: Correct.

CHAIRMAN WALLIS: And it's very fine material?

MR. KLEIN: It tends to be very small material that's highly hydrated. It's important to note here, too, that individual strainer vendors have adopted different approaches to integrated head loss testing.

Most of the strainer vendors are using as input to their tests the chemical model predictions. In other words, they would work through the chemical model spreadsheet and then calculate the amount of precipitate that's predicted for the plant-specific condition and then add that to their test.

Not all strainer vendors are doing that, however. Some have decided based on assessment that the model is overly conservative. Some have decided to try to do elevated temperature time-dependent tests more similar to IECT, only at higher temperatures over a 30-day period.

With respect to the actual adding of precipitate to these integrated tests, again, it's a mixed bag within the different strainer vendors. Some use a WCAP recipe to form the precipitates prior to the test and then add the solution to the test, simulate chemical precipitate. Others have injected chemicals into the loop similar to the ANL approach.

CHAIRMAN WALLIS: So they have done the large-scale tests with chemical reactions within the loop itself?

MR. KLEIN: Yes, there have been some tests done with addition of chemicals that would induce precipitation.

Slide 5. The purpose of this slide was to try to just highlight some of the areas where we have ongoing technical discussions with industry. And what I will do, I guess, step through each one and try to highlight some of the things that we are still trying to resolve with industry prior to issuing an SE.

Part of the WCAP approach, develop a precipitate, and you perform settling rate tests in order to assure yourself prototypical settling behavior.

And one of the staff questions has to do with the acceptance criteria that's within the WCAP. And we won't go into discussions with industry on that. And that's obviously important with respect to transport of the precipitate to the strainer surface during integrated testing.

We also have some questions that are ongoing with respect to the aluminum release rate equation that's in the WCAP. And that's most important since aluminum is by far the largest element that's released during these tests.

MEMBER BANERJEE: With regard to the settling rate, as we haven't seen the WCAP, we don't know. But are they suggesting some rate should be used in the calculations?

MR. KLEIN: The settling rate is just a measure that as they make the surrogate to add to the test loops, there is an effective concentration. So as you tend to concentrate the precipitate, agglomeration is favored. And it settles more quickly.

And so it's just to ensure that you don't have non-prototypical behavior that you artificially settle the precipitate out during the test, rather than having it arrive on the strainer surface.

Most strainer vendors intentionally create turbulence or agitation within their tests in order to make sure everything that is analyzed to reach the strainer surface actually does that during the integrated tests.

But there is one approach that is trying to look at settlement of both debris and chemical precipitate based on realistic approach velocities in containments. And so for those tests in particular, it is very important that the chemical precipitate settling rate is representative of what is expected in a plant and what was observed during the WCAP and other tests.

CHAIRMAN WALLIS: Well, settling rate is very sensitive to size and shape and any kind of flocculation and all sorts of things. And settling rate is a very sensitive parameter. So probably assuming that it doesn't settle at all is the best thing to do.

MR. KLEIN: That's correct. We also have

some ongoing discussions in a couple of areas related to peer review panel comments, such as potential effects from reactor coolant system oxides or effects of radiation.

And NRC has a working group internally that is going through each of the items as raised by the peer review panel. I think Rob Tregoning and Ervin Geiger in the next presentation will go into more detail about our approach and where that effort is headed. But, in addition, we have also taken these concerns to the industry via the RAI process.

And I think the last bullet here is an important one. The WCAP 16530 base model and the SE are going to be based on what we think will be conservative assumptions.

However, at the same time, the industry has a number of refinements that they are trying to pursue or are pursuing with additional testing. That is not part of the WCAP effort or the WCAP base model.

However, the staff sees these as very important. And so we have ongoing discussions with them on the areas such as solubility or passivation of aluminum by either phosphates or silicates. And so this is very much related to the WCAP but handled outside of the WCAP space at this point.

Next slide, please.

MEMBER ABDEL-KHALIK: So let me just ask this. The settling rate criterion is essentially an acceptance criterion as to whether the surrogate truly represents what is expected?

MR. KLEIN: It's an acceptance criteria provided within the WCAP to assure the individual vendor or whoever would conduct the test that they have produced a precipitate that is representative and as intended by the WCAP preparation technique.

MEMBER ABDEL-KHALIK: Wouldn't it be better to use a more primitive parameter to define the acceptability of the surrogates, rather than a derived parameter, like settling rate?

MR. KLEIN: I guess if you look at some of the things that they have done to try and look at the precipitate, its effect on head loss is of the utmost importance. So they did filterability tests to try and compare head loss at a precipitate. And that is one of the things that we followed up with at ANL, is to understand that their surrogate precipitate was as effective at driving head loss as some of the earlier precipitates that were performed in the ANL tests.

Settlement is a parameter that can be used to look at what is formed and see if it will transport in your integrated test in a way that is assumed as part of the WCAP preparation technique.

CHAIRMAN WALLIS: How about the material to block the Argonne screen, which you couldn't even see? That isn't modeled presumably in this WCAP.

MR. KLEIN: I would agree that we are not using an invisible precipitate that drove head loss out.

CHAIRMAN WALLIS: It was there. It was very, very fine or something. I forget. I just forget what it was called, but I remember that Bill Shack said you couldn't see it and it had a big effect on head loss.

MR. KLEIN: Correct. I think that that was accounted for in the WCAP approach because all of the solutions were --

CHAIRMAN WALLIS: How do you know a settling rate if you can't see it?

MR. KLEIN: I don't think we are producing invisible precipitates.

CHAIRMAN WALLIS: Not producing that stuff. Right. That's bigger than the ANL tests.

MR. KLEIN: Well, from the staff perspective, what we wanted to ensure was that maybe the invisible precipitate formed or in WCAP testing wasn't missed. And from that perspective, they did pass all of the solutions through a filter that you could probably argue is finer than what you might see in a fiber mat. So if the invisible precipitate was there, we should have seen head loss response during those tests.

I am on slide 6.

CHAIRMAN WALLIS: Well, it might mean that you need to make the stuff within the loop, rather than tossing it in as a powder.

MEMBER BANERJEE: Well, I guess that is the issue, right.

CHAIRMAN WALLIS: Right.

MR. KLEIN: It's not tossed in as a powder. It's pre-made outside of the loop as a hydrated amorphous precipitate, yes, as a slurry. And from our perspective, what we have seen is that the precipitate developed by the WCAP process is as effective or perhaps more effective driving head loss, compared to what we saw in the ANL test.

CHAIRMAN WALLIS: Is it stored in a bottle and it's poured in?

MR. KLEIN: It's stored, typically made in holding tanks and then poured in during the course of the test. That's correct.

CHAIRMAN WALLIS: Presumably if it's in a holding tank, the precipitate has all kinds of opportunity to agglomerate or change its physical nature or --

MR. KLEIN: It's one of the reasons that settlement tests are performed to try and ensure that the precipitate is behaving in the manner that was anticipated by the WCAP.

MEMBER BANERJEE: So if there are some effects, it's valuable that you said that there are some experiments where on a fairly large scale, they have been made in the loop itself, rather than added as a precipitate.

MR. KLEIN: There are tests done by one of the vendors where they inject sodium aluminate, for example. Instead of pre-producing an aluminum oxyhydroxide precipitate, they inject the chemical within the test loop. So the precipitation occurs within the test loop.

CHAIRMAN WALLIS: These precipitates, presumably they are nucleate and then they grow, but if they nucleate as very small particles, then they are being whisked around this loop. And they get filtered out before they have grown very much.

They would be very different. They would be like if they sat in the sump and grew for longer before they were filtered out. I'm not sure that this is modeled at all in any of these reports of the dynamics of the formation and growth of the precipitate itself.

MEMBER BANERJEE: I guess what you're saying, though, is that the surrogates are as bad or worse than when you grow them in the loop. But are these loops recirculating the loops or are they just once through?

MR. KLEIN: These are all recirculating loops. So material that passed through the loop through the strainer would come back around.

CHAIRMAN WALLIS: I'm not sure what's worse. If you have very, very fine particles, then that's --

MEMBER BANERJEE: No. They're saying the surrogates are worse.

CHAIRMAN WALLIS: We didn't say it was necessarily worse.

MEMBER BANERJEE: No, no.

MR. KLEIN: Well, I think what we saw was that the head loss response was very immediate and caused complete blockage at the ANL vertical head loss loop.

CHAIRMAN WALLIS: So it doesn't really give you any --

MR. KLEIN: It's harder to get worse than that.

CHAIRMAN WALLIS: It tells you don't do it. It doesn't give you any criterion for head loss at all on this.

MEMBER BANERJEE: Do you think making it horizontal -- you said you were careful to point out vertical head loss -- making it horizontal makes any difference with this fine precipitate?

MR. KLEIN: I think it does, yes, absolutely, because there has been testing done with the WCAP precipitate with both vertical head loss loops and with larger-scale flume tests, where you might have strainers that are oriented, such that you're approaching from the side. And it's clear that the vertical head loss loop tests have much higher head losses, even for the same amount --

CHAIRMAN WALLIS: Well, you make a uniform set to catch the preaccepted. Isn't that the main thing?

MR. KLEIN: Typically in those tests you have a flat screen. You have a uniform bed, and you capture all of the material. There is no chance for settlement. And even though these precipitates do settle very slowly, there is some settlement over the course of time. Typically you don't have 100 percent reach the strainer surface, even though you are recirculating the solution.

CHAIRMAN WALLIS: The question really becomes, what are you going to accept? I mean, you could legislate that to be conservative, will it assume it's a horizontal strainer, although it isn't?

MR. KLEIN: As far as acceptance, you know, I think our expectation has been that the individual licensee will run a test such that the amount of precipitate that's added and actually reaches the strainer surface is conservative compared to what they think will happen within their plant. And that seems to be the easiest --

CHAIRMAN WALLIS: Approach.

MR. KLEIN: -- approach. And if you try to model this thing in a scientific manner, it's very complex. And the actual precipitates themselves may be aging and changing over time. So it becomes a very difficult process.

MEMBER BANERJEE: But the problem with the precipitation being taken out is such a strong function of things like turbulence and vertical structures and things that you have.

And I have been looking through these calculations that people have done, the color-fluid dynamics. I'm not sure that this is really sort of the calculation that is going to tell you anything about that, you know.

So how can they guarantee that this would actually come out? The flume is not what the real situation is.

MR. KLEIN: I'm not sure if I understand the question.

MEMBER BANERJEE: I'm saying how much preaccepted comes out, anything comes out, deposits on the way to the screens or the geometry are a strong function of turbulence. And the turbulence calculations that are done in these types of geometries are extremely primitive.

So you cannot put any reliance on them. Therefore, you don't know the level of turbulence. Therefore, you don't know how much of anything, not just the --

CHAIRMAN WALLIS: So we'll assume none of the precipitate.

MEMBER BANERJEE: Yes.

MR. KLEIN: I think for the most common

approach to integrate a test, the strainer vendors are working very hard to get all the material to the strainer surface. So they're not trying to credit settlement other than there's one vendor, in particular, that's trying a new approach that will look at settlement.

But for the most part, they would calculate what makes it to the strainer surface and then they will work with stirrers or other mechanical means in order to make sure that stuff transports during the test.

MEMBER BANERJEE: Well, there is another factor. Sure, it makes it to the surface. But then how it distributes itself on the surface is also a function of turbulence and, you know, interfering bodies and stuff like that around.

So it's not a very simple thing to say what is going to happen other than they could be uniformly distributed, you know, which is why Graham said make it a --

CHAIRMAN WALLIS: I think that's what they're doing. I think where they can in these flume tests, they try to make the conditions as bad as they could be imagined.

MEMBER BANERJEE: Someone is going to

teach me CFD.

CHAIRMAN WALLIS: Then you won't rely on the CFD. Just try to make it as bad as you can imagine in the test.

MR. LEHNING: This is John Lehning from NRR staff.

As Paul said, most vendors aren't crediting that. There is one vendor that is attempting to credit settling of that precipitate, but we have had open items in some of the audit reports on simple particulate, not chemical precipitate, but other precipitate like zinc powder and other things and how you model the turbulence on that and whether a Stokes law approach, which is what these licensees had chosen, was adequate but because these particles are not necessarily perfectly spherical, they're not all uniformly sized, and there was not test data out there to benchmark that data. And similar comments would apply to the precipitate in my opinion.

MEMBER BANERJEE: I think one has to be extremely careful about these arguments of settling and non-uniform distributions being credited.

CHAIRMAN WALLIS: Identify yourself.

MR. LU: Shanlai Lu, NRR staff.

Related to that turbulence issue, I think that part is already mentioned in that for most of the other vendors except one, then they want to take credit of settlement. So most of the chemical precipitates really end up on the screen.

One particular one, which is one vendor, we have been working with them at this point to define the criteria, how to accept it but to resolve the particular issue related to the turbulence and then the plan to perform safety analysis and calculate the localized turbulence and then the test loop with the proposed view to have the downcomer to inject water to create the possible turbulence load very close to the strainer.

So that might be resolved in this issue, but it's an ongoing process. We are having a dialogue with the particular vendor to resolve these issues.

MEMBER BANERJEE: Yes. I noticed that one of the -- I don't remember who it was, but they were doing some CFD calculations and trying to say that we see this in the flume; therefore, the CFD calculations are right.

It's very easy to show something in a flume is right. It is very difficult to show in a real geometry that it is right. You know, they had some turbulent kinetic energy.

MR. LU: That's right. Yes. I think that is calculated based on CFD factored, averaged, based on certain average and taking it to apply to the loop to set up the testing.

MEMBER BANERJEE: Yes. We can discuss it, but I think it is sort of dangerous to depend on those things.

MR. LU: It's a challenge.

MEMBER KRESS: In the business of transport of aerosols, which is a severe accident issue, they finesse this issue by assuming the aerosols are always well-mixed in some sort of compartment volume and combined that with the Stokes law.

And these finessed bottles have been well-validated for containment --

MR. LU: Right.

MEMBER KRESS: -- and transport through the primary system.

MR. LU: Right.

MEMBER KRESS: You might look into that because it's supposed to be conservative when you do it this way, conservative where you get less precipitate.

MR. LU: Right.

MEMBER KRESS: But I don't know what you do with that Stokes law. You have to measure the settling grates and weigh in, relate that Stokes law.

MR. LU: I understand that.

MR. KLEIN: Thank you, Shanlai.

CHAIRMAN WALLIS: Well, also you don't have uniform temperature of the sump, do you? You have fluid coming in which isn't quite the same temperature as the stuff in there. So you have got convection currents presumably as well as turbulence. I don't know.

MEMBER ABDEL-KHALIK: You say that only one vendor takes credit for settling. Is that accounted for always in the experiments?

MR. KLEIN: One vendor approach that's trying to take credit for settlement, those tests have not yet been performed. The staff has been interacting with that vendor up ahead of the test to gain an understanding of their approach and to resolve any technical questions that the staff has.

MEMBER ABDEL-KHALIK: Because if one does not take care or take account of settlement in the analysis of experimental data, that would be non-conservative.

MR. KLEIN: Well, I'm not sure I

understand.

MEMBER ABDEL-KHALIK: Well, I mean, you are talking about a certain loading. And if you are measuring pressure drop and you do not take into account the fact that not all of the material is going to deposit on the filter, that would be non-conservative because you are getting a pressure drop for a lower amount of deposition.

MEMBER BANERJEE: You mean interpreting the result?

MEMBER ABDEL-KHALIK: Yes, interpreting the results of the data.

MR. LEHNING: This is John Lehning, NRR staff.

The way that we were trying to explain it is that that settling would be debris that didn't make it to the strainer.

MEMBER ABDEL-KHALIK: That's exactly the point I'm trying to make.

MR. LEHNING: So having more of that debris on the strainer, as opposed to settling out on the floor and not reaching the strainer, in general, you know, not always -- there are some thin bed cases or some cases where different debris mixtures with less can cause a higher head loss, but in general for the test plan that we have and the test plans that licensees are working with, having more debris reach the strainer, as opposed to settling out, would lead to a higher head loss.

MEMBER ABDEL-KHALIK: Yes, I understand. But when you analyze the data, what are you measuring? You are measuring the head loss, right?

MR. LEHNING: Correct.

MEMBER ABDEL-KHALIK: And you are attributing that head loss to a certain amount of material that is deposited on the filter.

MR. LEHNING: Correct.

MEMBER ABDEL-KHALIK: And that amount that is deposited on the filter is the total inventory minus the amount that is settled.

MR. LEHNING: Correct.

MEMBER ABDEL-KHALIK: So if you don't take into account the amount that is settled, you are actually underestimating the effect of the material that is deposited on the filter, which would be non-conservative.

MR. LEHNING: An easy way to answer that question for the vendors that are using artificially generated turbulence that is well in excess of the amount of turbulence in the plant would be to show that that is far more conservative than the transport conditions that would occur in the actual plant in the test. And that would bound the small amount of debris that won't reach the strainer during the test. And we see that.

And that is something that when we go and take trips to observe tests, we look for the amount of debris that does not reach the strainer and make sure that that is an insignificant quantity. And if it isn't, then we ask vendors to justify that that settling is prototypical and they have to have a technical basis for that.

CHAIRMAN WALLIS: Well, actually, with a thin bed effect, it can be the other way around that you need more material on the screen in order to dilute the fines to get less versatile. It's not clear that having less material on the screen leads to a lower pressure drop.

MEMBER ABDEL-KHALIK: I think the point I am trying to make is that if you are analyzing experimental data, if you don't take into account the fact that some of the material will settle down before it actually deposits on the filter. That is non-conservative.

MR. LEHNING: I see your point now. In a

way, that is true, but these tests are just to show that this experimental test is what is being used to qualify the strainer. It's not as if there is some correlation that is being used to correlate this amount of debris.

If that were being done, then I would agree with what you're saying. But the point is just to show that that task is representative and bounding of the plant condition.

MEMBER BANERJEE: But that's I guess what is bothering a lot of us. Imagine you do a test in a flume and you put whatever it is, the screen, whatever geometry, and you bring some stuff with debris and as long as the debris sticks and gives you a pressure loss.

Now you go to the real system. And you have got these top hats or whatever they are, some arrays or stacks, some of them, some in disks. You know, now the whole situation, the local fluid mechanics around these is very different from having these go in a horizontal flume.

And, for example, if you took a single stack, let's say, and you tested it, it has certain surface area. Now if I put it one on top of the other and I fill things in, you know, it will start to, the debris will start to, get in between there.

You know, so that approach velocity is no longer the approach velocity perpendicular to that stack but, actually, if the approach velocity is just the opening of this -- do you see where I am getting at now?

MR. LEHNING: It's the dynamic effect that you have built up.

MEMBER BANERJEE: Yes. Everything is changing all the time. Now, what is worrying to me is that when I read some of the stuff, they're talking of CFD calculations where they are actually looking at tumbling velocities and precipitation rates, which is almost impossible to do in a CFD calculation.

I will give you a very simple example. That a flume. Okay? Just put some polystyrene particles in it. Okay? And what you will find is the velocity of the liquid is higher at horizontal flume than of the polystyrene particles. Why is that?

If any of those codes can actually be predicted, I would be happy to see it. If not, because there is no force, this is a horizontal, get the particles that are lagging, the velocity of the liquid. None of these codes can do that. So it's very dangerous to rely on them at all.

MR. LEHNING: Yes. I'm not going to try to answer that question, but the CFDs I just used for the flow. And they're not used directly for the debris transport part of it. And they're used away from the strainer as well. They're not generally used --

MEMBER BANERJEE: That's even more worrying that they're used anywhere. But I want to revisit this thing with CFD when it comes up.

CHAIRMAN WALLIS: Paul, can you get us to the end of this presentation, do you think?

MR. KLEIN: Yes.

MR. SCOTT: Mike Scott.

Before we go further, are you suggesting that we should be taking a different approach here?

MEMBER BANERJEE: Yes. I think it's very difficult to take an experiment like this and glue it together in the real geometry of the CFD, at least the current type of CFD which is being done.

MR. SCOTT: So what are you suggesting that we would do instead?

MEMBER BANERJEE: You might need to do tests which are in more typical geometries directly?

MR. SCOTT: Typically of?

MEMBER BANERJEE: Of the real stacks, of

the real arrays or whatever the --

MR. SCOTT: But the testing that is being done by the licensees attempts to replicate those kinds of geometries at a scale. It's not full-scale, but it takes a strainer array and it imposes the conditions in a particular plant's containment. I mean, like if there is a wall nearby, that wall will be represented. So that sort of thing is going on.

MEMBER BANERJEE: Yes. I don't know. I haven't heard from them. But what I have seen of the very few graphs which we got in the slides, some of they seem like they were basically tests which were being done in flumes. You know, they were not typical geometries, typical arrays of things. I could be wrong.

MR. SCOTT: Well, maybe that would be a good question to ask the sample licensees who are going to be presenting for you because --

MEMBER BANERJEE: Who are going to present because if they are more typical, I feel much more at ease about that, you know.

CHAIRMAN WALLIS: Can we move on now?

MR. KLEIN: Okay. I'm on slide 6, staff perspective. I think the WCAP test did provide some value, supplemental information, IECT, expanded the range of pH temperatures and also materials, particularly the non-metallics.

Some of the limitations in the WCAP include mostly single effects tests, the total precipitates achieved by some of the individual test results. And the characterization of the precipitates themselves is based on EDS scans of the area. It's not quite the definitive answer that you might get with more sophisticated techniques.

Our preliminary perspective, however, is that the base model was conservative. And the following slide will touch on some of the reasons why we believe that.

If you look at the WCAP methodology as a whole, they put a variety of materials into the test solutions at elevated temperatures for short-term durations. And then for the cases of the three predominant species that went into solution, which represents 99 percent of the total mass in solution during the WCAP tests, they assume that that material precipitates as soon as it goes into solution. And that is --

CHAIRMAN WALLIS: Do you mean as it precipitates on the screen?

MR. KLEIN: Well, it precipitates within

the pool.

CHAIRMAN WALLIS: It doesn't settle out?

MR. KLEIN: It does not settle out.

CHAIRMAN WALLIS: It makes a precipitate which goes around the loop in some way. Either it goes into the screen or through the reactor or something. It stays in suspension.

MR. KLEIN: Yes. There are two pieces to this, really. The WCAP itself does not predict what happens to the precipitate once it forms. The strainer vendor tests if they use the WCAP methodology take the amount predicted by the WCAP, and then they put that into solution. And then they typically force that to the strainer or it passes through and comes around again but eventually through flume turnovers or pool turnovers reaches the strainer surface.

CHAIRMAN WALLIS: So it's assumed to precipitate in solution? It's not allowed to precipitate by deposition on the fuel, for example, if you have an inverse solubility curve?

MR. KLEIN: That's the --

CHAIRMAN WALLIS: It's very different. A way to get it into the core might be not to precipitate it until it gets there.

MR. KLEIN: That's a different topic. And the assumptions for the in-vessel aren't necessarily the same as for the strainer.

CHAIRMAN WALLIS: Okay.

MR. KLEIN: For the strainer, it's conservative to assume that all precipitates in solution arise at the strainer surface for the in-vessel, that is not a conservative assumption. And that's not an assumption that --

CHAIRMAN WALLIS: Okay. You make assumptions?

MR. KLEIN: Correct.

CHAIRMAN WALLIS: Okay. Thank you.

MR. KLEIN: The model also doesn't really consider that there might be a delay in precipitation due to sluggish kinetics or some other effect. If you look at IECT, for example, the aluminum oxyhydroxide that formed in IECT 1 and IECT 5 primarily occurred after the solution began to cool from a 140-degree test temperature.

The WCAP model itself assumes that this material is immediately available. And so when licensees implement an integrate head loss test, they're typically assuming a 30-day inventory of precipitate. And they're evaluating that against a minimal NPSH margin that is available in their plant.

As time goes on after an accident, that margin increases substantially. So that is a conservatism.

They also in the base model do not consider passivation of aluminum by phosphate or silicate. And we did observe those phenomena in the IECT tests. It has also been confirmed by additional tests, either by industry or at LANL. So we think those things are real, but the base model does not consider it.

So the first three bullets really are related to treatment within the WCAP process. These last two bullets discuss tests that the staff has requested in order to help evaluate different aspects of the WCAP model.

In particular, the tests at ANL that you did hear about in February, we took an amount of precipitate that would be the equivalent of the Argonne vertical head loss loop volume if it had five parts per million in excess of solubility limit, for example, that transformed into precipitate. We wanted to see how that would affect head loss. So we ran a test with what we thought would be a small amount of WCAP-generated precipitate.

When we did those tests, we saw a very immediate head loss response that resulted in complete blockage of the loop. In fact, they had --

CHAIRMAN WALLIS: It seems to me a problem because we haven't sort of quantified the effect of these precipitates on head loss except that when you get some, it seems to make an unacceptable head loss.

I'm not quite sure how you are going to predict what is allowable in terms of amounts of precipitate in the plant. They don't really know what the effect of a small amount is on head loss.

MR. KLEIN: Well, the criteria for the plant, really, is that the NPSH margins are met. So if the precipitate causes --

CHAIRMAN WALLIS: How do you predict that?

MR. KLEIN: How do you predict that?

CHAIRMAN WALLIS: How do you predict it? Do you do it just by experiment?

MR. KLEIN: You do it by experiment by the plant-specific debris that is added to the larger scale tests. And then they add a conservative amount of chemical precipitate on top of that.

MEMBER BANERJEE: So the key thing here would be for us to listen to these presentations which are coming.

CHAIRMAN WALLIS: So it's conceivable that Argonne got essentially complete blockage with five parts per million, but it may be with certain screen designs you don't get complete blockage or you get almost no blockage up to maybe -- I don't know -- 20 or 50 parts per million or something.

MR. KLEIN: Well, and it's a function of also the individual plant whether they have a debris, a fiber bed on their strainer, something --

CHAIRMAN WALLIS: There is nothing quantitative you can take from Argonne and apply it to your decision-making.

MR. KLEIN: That is accurate, I think.

CHAIRMAN WALLIS: Yes. It's just a qualitative --

MR. KLEIN: I think what it showed us qualitatively is that the WCAP precipitate effectively drives head loss. So if you have a methodology that predicts a conservative amount of precipitate, then that should be conservative.

And also, in addition to the head loss test, Argonne also did a series of bench-top tests to try and understand sensitivities on preparation of the WCAP surrogate and how it could potentially if you did not follow directions exactly, what would be the ramifications on the precipitate that was formed.

And then the final larger bullet here

talks a little bit about the test at Southwest Research. And we really had two objectives with these tests. One of them was to take a limited number of WCAP test conditions and try and replicate them just to see the different test facilities, different heater material, but the same material, same test condition, what might happen relative to what was reported in the WCAP.

So those sets of tests were done. And, in general, what we saw is that in the Southwest Research test, the concentration of leachate was either similar to or less than what was reported in the WCAP.

The second part of the Southwest Research was to pick out some of the materials that were not tested in the WCAP. If you look at the WCAP methodology, they classify materials.

And then they tested a representative material from each of those classes. We wanted to evaluate some of the other materials that were deemed equivalent to some of the material classes and see how they would behave as well in this type of test.

So when we did those tests, we did not observe any precipitates with those other additional materials that were not tested within the WCAP.

Slide 8.

CHAIRMAN WALLIS: Maybe we could just read this one and move to the last one.

MR. KLEIN: You can certainly read slide 8 and move on.

The final slide talks about the regulatory path forward. And there are really four major areas shown in this slide the staff is working on to try and prepare ourselves to evaluate the chemical effects evaluations that will be provided in the supplemental responses to --

CHAIRMAN WALLIS: What if the Commission asks us at the meeting in June "Are the staff and industry are on track to resolve GSI-191?" We will probably have to say we don't know. We just have to say they're still evaluating.

MR. KLEIN: That is true. I think that there is an aggressive schedule that both industry and staff are trying to meet here. This is clearly a complex area.

And, as you will see, the bottom line of this slide will talk about the individual areas, but any one of these four bullets could really trigger requests from the staff for additional confirmatory research in order to support resolution of chemical effects.

But, in particular, path forward, we will be working with the Office of Research to disposition the peer review panel member comments contained in NUREG 1861 and identified by the PIRT. You will hear more about that in the next presentation.

We are continuing our assessment of the ongoing industry chemical effect tests. We are --

CHAIRMAN WALLIS: So you aren't able to say, "We had ten questions, and we have successfully resolved eight of them" or anything like that? You've still got all of the questions. Is that right?

MR. KLEIN: For the peer review panel and the PIRT?

CHAIRMAN WALLIS: No. For the state of where you are in resolving GSI-191. My impression is that the questions are still the same and the answers aren't yet finished.

MR. KLEIN: In the chemical effects area, I think that we have definitely made progress. I think we're learning --

CHAIRMAN WALLIS: You haven't answered any questions completely yet?

MR. KLEIN: Well, we have answered certain aspects of it. We certainly have some larger technical issues that remain to be resolved.

MEMBER BANERJEE: Is it correct to say that you are guided by what has been done, you are relying very heavily on industry experiments in prototypical geometries, large-scale prototypical geometries, as a means of evaluating?

MR. KLEIN: I think that's one important piece of information that we will rely on, certainly not --

CHAIRMAN WALLIS: Okay.

MEMBER ABDEL-KHALIK: Does approval of WCAP 16530 imply approval of the surrogate characteristics and preparation method, regardless of the plant-specific conditions?

MR. KLEIN: I think the safety evaluation will be written for WCAP 16530, might approve the overall process as conservative, including the use of those surrogates.

Now, I think what maybe didn't come out as part of this presentation and the real challenge to the staff is that I've sat here and I've sort of described overall we think this base model is conservative. And I've provided some of the reasons for that.

At the same time, there is work underway to try and remove some of that conservatism. And so the challenge I think for the staff is going to be trying to understand how much conservatism can be removed from that base model and still have a conservative method overall.

CHAIRMAN WALLIS: Okay, well we've had a very liberal interpretation of the agenda and the time frame that I would like to finish. Thank you very much, Paul.

We are going to take a break now for lunch until 12:30.

MR. KLEIN: Thank you.

(Whereupon, a luncheon recess was taken at 11:40 a.m. until 12:34 p.m.)

CHAIRMAN WALLIS: Okay, this presentation will be pursuant from this morning, the staff presentation on Chemical Effects Peer Review.

Rob, are you going to start?

MR. TREGONING: Yes, yes, sir.

CHAIR WALLIS: Please go ahead.

MR. TREGONING: Thank you, Mr. Chairman.

I'm Rob Tregoning from the Office of Research. And seated up here with me is Erv Geiger from the Office of Research. And we are going to present a status update of the Chemical Effects Peer Review and how we are working through issue disposition.

Slide two please. This is really a status presentation. We were originally in front of you in both February and March where we presented a lot of the mechanics and history. And actually talked about some of the issues that were raised by the peer reviewers.

And we said at the time that we would come back during this May meeting and let you know how we were progressing. And what we still had to do in the future. So these first couple of slides are just to revisit that earlier presentation to make sure we have what we are doing now in proper context.

So as we indicated back in the February and March meetings, many important chemical phenomena were identified by the team of five peer reviewers that we put together. And there were one of two mechanisms that these phenomena or issues were identified, either in NUREG 1861, which you have seen and reviewed and actually commented on quite in depth in the last meeting that we had which was their review of the research that we had conducted in the area of chemical effects up to that time that was published in December 2006.

And the other mechanism was the PIRT that we conducted and we decided to conduct in the middle of their peer review when it became apparent to us that many of the issues that were being raised at the time were outside of the scope of the initial research efforts. So combining those two documents or activities led us to identify various phenomena.

After the PIRT, once you took into account the rankings from the PIRT process as well as some of the extraneous issues that were in NUREG 1861 that were identified specifically in the PIRT, we were able to identify 41 phenomena or issues that we needed to disposition as a staff.

So that's -- and I'm very definitive when I say 41 because I'm going to provide binning statistics later. I want to make sure everything adds up. So I didn't say approximately 40 because I know you guys will do the math later.

CHAIR WALLIS: So someday we'll got a checklist of 41 issues to check off?

MR. TREGONING: Yes. We have actually formed a table of all these issues. And one of the columns in the table is the disposition strategy as well as the technical justification supporting that. And that will be documented.

Next slide please. Again, this is just a repeat of what was provided in February and March. If you looked at the issues and categorized them, they fell into one of these seven bins. And back in February and March, I gave about ten different examples that fell within each of these bins.

CHAIR WALLIS: Can we give this number to the Commission when the Commission asks us in our June meeting what is the status of chemical effects phenomena. We'll say the staff has 41 --

MR. TREGONING: Sure.

CHAIR WALLIS: --phenomena.

MR. TREGONING: These slides are publicly available.

MEMBER BANERJEE: And also this was identified by the peer review group, right?

CHAIR WALLIS: Yes, but you actually looked at the peer review. You might have discarded some of them as not worthy of further consideration.

MR. TREGONING: Well, the PIRT process itself, you obviously go through a ranking. When we did brainstorming as a group, there were well over 100 that were identified.

CHAIR WALLIS: That sounds a large number to me.

MR. TREGONING: No, again, when you go

through any sort of PIRT and when you do it comprehensively, you identify a lot of potential phenomena and issues. So, again, in the original brainstorming, now these statistics I don't have exactly right, but I want to say it was probably about 120 specific phenomena that we identified and ranked.

So ideally yes, it seems like a large issue, but the other thing is we tended to be inclusive rather than exclusive. So if there was any doubt about whether we had sufficient justification to conclude that something was or wasn't significant, we tended to include it so that we could at least have staff discussion on it.

MEMBER BANERJEE: So these are not necessarily what would be highly ranked?

MR. TREGONING: Not necessarily although certainly all of the highly-ranked issues were included in this list. We had a few issues that actually -- the aggregate score was low ranked but if we had one peer reviewer that had sort of a passionate justification for why it shouldn't be ranked low, we tended to throw those into the mix as well.

So again -- and that is something that you don't always do in a PIRT. So we tried to err towards inclusivity rather than exclusivity in this. And, again, a few of the issues weren't even raised in the PIRT. They were raised outside the PIRT within NUREG 1861.

Next slide please. So how have we gone about evaluating these various issues? And this really follows on the proposed path that we talked about in February and March. We formed a team from NRR and Research that is going through and separately evaluating each of the items. And we have been through an initial binning of each of those items. I'm going to give you the results of that shortly.

And when we look at these items, we're trying to identify or evaluate them based on information that wasn't available to the PIRT reviewers at the time. Because, again, the expertise of the PIRT panelists largely were chemists, chemical engineers. We had one PIRT panelist that did have specific and direct industry experience.

But there were a lot of aspects about specific plant conditions as well as the industry mitigation strategies for chemical effects that either weren't apparent at the time because they have evolved since or, again, there was not enough knowledge from the peer review panel itself to really accurate or intelligently comment on the effects of some of those things.

So we have considered these first two bullets in our evaluation to identify which issues we still think are still outstanding.

Now in future, for those issues that either the industry mitigative approach or consideration of plant conditions aren't in and of themselves sufficient, these last two bullets indicate some future steps that we are looking at taking to continue the evaluation.

The third bullet is staff is considering some scoping analysis. And by scoping analysis, I wanted to define what we meant by that because that can be a vague term. We are talking about here within the context of this is either literature review, conservative calculations, or limited conservative experiments.

The purpose for that would be for any specific issue to try to provide some context to determine who significant this issue would be.

So we are really trying to look to do something fairly conservative to make that initial assessment.

And then finally for those issues that remain, we will be, you know, considering and evaluating the need for any targeted follow on either industry and/or NRC sponsored research. And, of course, that last bullet is something that we -- for some of these issues, you know, you will see that we have continued to work in parallel. It is the belief of at least portions of the staff and some of the currently industry sponsored research on chemical effects as well the pending research that will go on this summer will address some of the issues that were raised by the PERT team. So this -- did you have a question?

CHAIR WALLIS: No, I'm just looking ahead.

MR. TREGONING: Okay, okay. The other thing that we are doing in parallel is we are documenting and summarizing the PIRT process. And item four, we have been in parallel communicating. Much of these issues have already been communicated to the vendor teams and the licensees through either the RAIs that Paul spoke about or other mechanisms, public meetings, and otherwise. So we have been communicating that information to these teams so we can facilitate in as timely a manner as possible the resolution of the generic letters.

As we've already discussed today, we are on a challenging schedule. So we are trying to do many of these things in parallel as much as we can.

So slide five is a bit of a process slide but I thought it was important to at least show this. This at least shows the binning or the screening strategy used by the staff in terms of evaluating the phenomena or the issues that have been raised by the peer reviewers.

CHAIR WALLIS: Can we move over to slide six now?

MR. TREGONING: Okay, we'll go to slide six. We can come back to that if we need to.

CHAIR WALLIS: All right. Now the interesting thing to me is that 34 of them became deleterious chemical vendors.

MR. TREGONING: Yes, yes. So you can see there what I've tried to do is -- just before we move on --

CHAIR WALLIS: You were unable to screen out many of these. Most of them survived as being important -- potentially important.

MR. TREGONING: Right. There were a few that had no practical implications, as you see. There were a handful which were advantageous. And then 34 which were potentially deleterious. However, of those 34, the current belief among the staff is that we have sufficient available information to disposition about half of those. So there is really another 19 remaining which we think we need to have some additional consideration in order to properly disposition.

MEMBER BANERJEE: Can you give us an example of one?

MR. TREGONING: The next slide I have examples. So let me work through this slide and then we'll give you some examples. And what I've done is I have given examples of things that fall within each of the bins so you can see some of the differences.

What else are we doing? The draft PIRT report I mentioned, we have actually completed the draft version of that report and the target completion for the final report this fall of `07. And, again, we are considering scoping analysis to support the generic evaluation. And that would support resolution of those 19 issues there. The target completion for that, if we embark on that, would be December in parallel with the generic letter resolution.

And I just mention some of the venues that we are using to communicate this information to the vendors and licensees. And I mention bimonthly public meetings. The next one is June 20th. I think Michael

Scott had indicated June 18th earlier. It is actually, I think, June 19th. So let me point out that error on that slide.

CHAIR WALLIS: Usually we are less interested in process than we are in results.

MR. TREGONING: Yes. Yes. So let's go to at least some example results on the next slides. And I don't have all the results. If you remember in February and March I presented ten issues that were representative of the types of things that were raised by the PIRT.

I've taken five of those ten that happen to fall within different bins so you could see what types of things were falling in different bins so, for instance, one of the issues that we discussed and addressed in the PIRT was the fact that there needed to be sufficient particular nucleation sites in order to foster precipitation, okay?

And essentially what came out of the PIRT as well as subsequent discussion is that in either a normal or laboratory environment or certainly in containment, that you are going to have enough of these sites available that will be enough to foster precipitation.

We have also, both in some of the NRC-sponsored research and in the industry-sponsored research, looked at addition nucleation sites through the form of either nano particles and RKs. I'm not sure of the size scale of the industry particles but in either case, whenever we have added more particles, they did not seem to have any noticeable effect on the precipitation mechanics or kinetics.

So that would tend to reinforce what was already some of the information we got from the peer reviewers that the expectation was that there was sufficient sites available in these typical environments. So there is one where we believe that there is no practical implications of that particular phenomena.

The second item, and I had mentioned this before, was the fact that you can have quiescent settling of participates. At least with respect to sump screen head loss, this is something that by and large is an advantageous effect with respect to ECCS performance.

But other than the scaling analysis that you mentioned earlier, that is a separate issue, but with respect to actual performance, if you do have settling or conditions which allow larger, more stable particles to form, which then have a greater propensity to settle, that certainly could decrease the solids inventory that you have.

CHAIR WALLIS: What do you mean by a stable particle?

MR. TREGONING: Stable particles meaning that they are -- I mean hydrodynamically stable there. So they are not going to --

CHAIR WALLIS: Break up?

MR. TREGONING: -- break up. Yes.

CHAIR WALLIS: They won't break up.

MR. TREGONING: Yes. And if you have quiescent enough conditions that allow the growth and nucleation and then potential agglomeration of those particles, they can be much more resistant to either break up or redissolving in solution after the fact. And we have actually seen some of that in some of the benchscale testing that we have done when we have tried to redissolve or resuspend things that we had allowed to form under --

CHAIR WALLIS: One of your items that came up in the PIRT, this formation of gas in the sump that makes particles then rise to the surface by buoyancy, can some of these chemical reactions produce gas? Hydrogen?

MR. TREGONING: Yes.

CHAIR WALLIS: And the gas bubbles then make particles rise up. And then they -- the bubble breaks and they cascade down again. So this settling is effected by that.

MR. TREGONING: Yes. And how you --

CHAIR WALLIS: Is this one of your items you are looking at?

MR. TREGONING: One of the items that we looked at was actually the effects of organics on buoyance which --

CHAIR WALLIS: How about bubbles? Are you looking at bubbles?

MR. TREGONING: Bubbles only with respect to how it effects the overall turbulence within the pool. I mean you

CHAIR WALLIS: They actually make certain particles buoyant that weren't buoyant before.

MR. TREGONING: Yes, but once -- right but it is potentially a transient effect as well, especially with hydrogen. As the bubble goes --

CHAIR WALLIS: Yes. Just because something settles into a sludge at the base doesn't mean to say it is not going to be buoyant --

MR. TREGONING: That's right.

CHAIR WALLIS: -- because of chemical

reactions within the sludge.

MR. TREGONING: That is entirely correct.

CHAIR WALLIS: So add it to your list if it isn't there already -- 42.

MR. TREGONING: Well, whenever you have a new PIRT panel, you open yourself up for additional issues. Okay.

The next one as we go down the table, pH variability. Here is one that the peer reviewers thought was very important with respect to both the initial break chemistry and the fact that that is variable throughout the fuel cycle depending on the amount of boron that you have in your RCS.

And the related issue is the fact that we know that containment chemistry will evolve post-LOCA as a function of time as the buffer continues to get added. So that is an issue that was rated of high importance by the peer reviewers. But this has been an issue that has had a lot of interest and examination. And this is something that the industry has been considering and evaluating in their generic letter evaluations all along.

So this is something that at least with respect to this particular issue, there is an expectation that this will be addressed by the industry in their generic letter submissions. And it is sufficient mature enough so that the variability can be understood.

CHAIR WALLIS: Boron is needed for criticality control, isn't it, early in the cycle?

MR. TREGONING: Yes.

CHAIR WALLIS: So you don't want it precipitating out.

MR. TREGONING: Yes, that is correct. And that is what leads to -- when I talk about initial break chemistry being variable, specifically I'm talking about --

CHAIR WALLIS: Are you adding more boron later on in the scenario?

MR. TREGONING: Yes, you inject it as well in the scenario, yes. And that's what drives the chemistry, the injected boron levels are typically higher than you would get in your RCS level. And that drives the chemistry.

But at least very early on, the RCS chemistry will drive the chemical reactions. But it is a relatively short time period before that injection starts. So over the post-LOCA sequence, that aspect is a very small percentage.

MEMBER ABDEL-KHALIK: So people would have to do their LOCA analysis at different burn-ups?

MR. TREGONING: They would have to potentially consider those effects. But, again, that is a very small window compared to the whole post-LOCA scenario. I think you heard today that most of the licensees are taking products that would develop over 30 days. Because, again, these products are evolving with time.

So they are making conservative assumptions that those 30-day products are available to judge or evaluate their minimum net section head loss margin which would occur after like an hour or so into the accident.

CHAIR WALLIS: Do they stay subcritical forever.

MR. TREGONING: Yes.

CHAIR WALLIS: Or 30 days -- you mention 30 days.

MR. TREGONING: We say 30 days. But you have got to be able to cool it, yes.

CHAIR WALLIS: You've got to cool it and if it is, you know, low burn-up material, you have to keep it subcritical --

MR. TREGONING: That's correct.

CHAIR WALLIS: -- for a long time

presumably.

MR. TREGONING: Right. So there is nothing magical about 30 days although it is -- beyond 30 days, you know, if additional cooling is needed, A, you have a lot of margin, and B, you also have the potential for developing other ways of cooling. So 30 days has been --

MEMBER ABDEL-KHALIK: Do current LOCA analysis account for or keep track of pH variation during the transient?

MR. TREGONING: Yes, I might ask Paul to jump in on this. But essentially yes would be my answer.

MR. KLEIN: I think once you have a LOCA, it is a very, very short time frame for blow-down. I think what we were trying to address in part of this bullet is that you have a fine dependent evolution of pH. You initially have very low pH, highly borated water from all your injection tank sources.

And that as you either spray sodium hydroxide or you dissolve TSP, that pH adjusts over time. And that is part of what goes into the spreadsheet input as a function of time. And it is accounted for as they try to determine what forms as a precipitate.

MEMBER ABDEL-KHALIK: So is this something that would have to be integrated within LOCA analysis methodology? Or is this sort of a separate side calculation?

MR. TREGONING: It could be integrated or it could be considered -- it could be conservatively handled as well. I mean depending on which aspect you are looking at, if you are looking at corrosion or dissolution, you could make conservative arguments in terms of what you pH is and how you are evaluating that corrosion or dissolution.

So there are at least two ways to handle it. More realistically or more conservative. And I'm not sure if you can comment in terms of what the expectation is for particular approaches from licensees. Do you have any --

MR. KLEIN: No, I think the -- you know part of the disposition of this is that the amount of corrosion you get during that initial 30-second period is very small relative to the amount that accumulates over the subsequent 30 days.

MEMBER ABDEL-KHALIK: I mean it seems like temperature and pH are the dominant variables that at least were examined experimentally. And if you are going to, you know, take advantage of the experimental data, you ought to be able to provide at least reasonably accurate estimates of the time history of these two parameters. And the question is do the current analyses do that?

MR. KLEIN: Yes. Temperature and --

MEMBER ABDEL-KHALIK: Temperature I can understand. But pH --

MR. KLEIN: And pH is predicted as a function of time.

MEMBER ABDEL-KHALIK: Okay.

MR. TREGONING: Okay, thanks, Paul.

Another issue that we talked about was silica concentration. These were things that we did -- we certainly accounted for silica within the ICET test in the sense for the insulation materials that we had as well as concrete. But we did not explicitly consider silica in the RWST or RCS, how that might contribute to the chemical products that could form.

Now when we looked at that again and evaluated that in terms of the RCS contribution, there is really a negligible contribution to additional silica compared to what was considered in the ICET analyses were we typically had, depending on the test, anywhere from 80 to 100 PPM of dissolved silica.

So the idea at least behind that issue is that we have well-encompassed the amount of silica that we would need to consider within these sump pools by the testing that has been done.

CHAIR WALLIS: Well, it is a continuous process. I mean if this stuff is precipitating in the core, then it is continually being dissolved in the sump presumably. And then re-precipitated in the core. It is not as if it is limited by some parts per million. It is what happens in that cycle that matters, isn't it?

MR. TREGONING: Well, in terms of how much -- in terms of if you get re-dissolution of solid product, that is certainly important. But I guess the point here is that the expectation is that most plants will have well in excess of that amount or that concentration in silica due to other sources without necessarily having to account for silica that may exist initially in the RWST and RCS.

CHAIR WALLIS: So what you are saying is there is plenty of silica from everything else?

MR. TREGONING: Yes, in general.

Now, again, maybe if you had a plant that was able to demonstrate that they effectively had very little silica, this issue would --

CHAIR WALLIS: Well, I think our problem

was this species of retrograde solubility. But they are also formed from the other silica.

MR. TREGONING: That's right.

CHAIR WALLIS: Okay. So it's not --

MR. TREGONING: That's exactly right. Yes, so I apologize for the confusion there.

CHAIR WALLIS: So the two things are sort of mixed up.

MR. TREGONING: They are mixed up. So, yes, I apologize for that.

And then the last item is one that we talked about. And that is effects of radioloysis. And there are various effects potentially of radiolysis that fall into these other bins. I just picked one out here. And that's the effects on the redox potential. And essentially the corrosivity of the environment itself.

And this is something that we are considering for doing some of these additional scoping studies.

MEMBER BANERJEE: So would these be in sort of a little ICET set up or what?

MR. TREGONING: You know, it is premature at this point to comment. I think with respect to this particular one issue, I think at least I would envision some limiting scoping calculations on how radiolysis might effect the redox potential compared to the redox potential that we had, for instance, in the ICET test.

And if we could demonstrate that the redox was not significantly different, they you potentially have a justification for saying okay, the additional effects for radiolysis aren't a significant consideration.

Now if we are not able to make that case, then you have to think about okay, well then how do I evaluate the effects of radiolysis. And then that potentially takes you to a point where you have to consider some sort of testing, more refined calculations, you know whatever you need to do. But that is the whole point behind the proposed scoping analysis was we will try to evaluate how important this is.

MEMBER BANERJEE: The thing is you might be able to -- you may be able to get rid of chemicals but you may not be able to get rid of what radiolysis effects.

MR. TREGONING: That's correct.

MEMBER BANERJEE: So one must have a feel whether it is important or not.

MR. TREGONING: Well, and that's why -- hence -- and you asked about, you know, lack of buffering before, you know, and what questions would remain. Well, this would potentially be a question that would remain. So there is not an expectation that there would be no chemical effects if we removed the buffer. They would just be different effects likely.

MEMBER BANERJEE: Right, right.

MR. TREGONING: And Paul had mentioned some of the German experience with some of their testing. They do not buffer. And they have still, Paul had mentioned, corrosion of zinc. But then also they have also seen some iron corrosion as well.

So they still have chemical effects. They are just different effects.

MEMBER ABDEL-KHALIK: Back to the pH variability issue, the dissolution data was based on experiments that were done over 90-minute periods in which the rate is assumed to be constant and equal to whatever the total amount after 90 minutes divided by 90 minutes, that gives you the rate.

So how can you use this information along with a very fine resolution of calculated temperature and pH over a time frame of seconds?

MR. TREGONING: Well, that's a broad question. You know I don't want to tackle all the industry aspects of it. But I guess what I will say is the industry tests were 90-minutes tests. And they were looking at calculating rates, reaction rates. There has been a lot of other similar small-scale as well as large-scale tests where we looked at fairly earlier on sampling as well as longer sampling to catch saturation effect.

So although I don't think I'm answering your question because your question -- let me make sure I understand it again, you are saying how can we take that reaction rate data and resolve fairly small differences or fairly fast differences in pH?

MEMBER ABDEL-KHALIK: And within that 90-minute period over which the averaging is being done. One would expect some variation with time --

MR. TREGONING: In terms of pH or temperature or --

MEMBER ABDEL-KHALIK: Or dissolution rate. And the issue then is, you know, how can you use time averaged data over a 90-minute period along with calculated temperature and pH history that are resolved to the tenth of a second time scale? And what would be the value of doing that?

MR. TREGONING: Well, I think what you will see, especially with respect to chemical effects, is -- and this is something that we looked at initially when we were developing the parameters for our ICET testing -- and if you recall, ICET was an isothermal test. And we did some speciation calcs to try to predict at least, you know, dissolution and the amounts of materials that would occur to the relatively high temperature yet very short duration part of the event versus the lower temperature, longer-term aspects of the event.

And in terms of the actual amounts of dissolved species, it was always dominated by the longer-term history. So while in essence it's true that you need to consider all those effects, at least by and large with respect to the amount of chemical species that is available, it is really that longer-term, lower temperature effect on submerged materials more than un-submerged materials, that is going to result in the dominant contributions to the containment pool chemistry.

MEMBER ABDEL-KHALIK: I'm just questioning the logic in the sense that I don't know how much effort will be involved in resolving this pH variability issue. And whether you would require people to do LOCA analyses at different burn-up so that they can find out what is the worst condition in terms of the calculated pH and temperature history, whether that is your plan or not. And whether that is consistent with the level of detail as far as experimental data.

MR. TREGONING: You are going to have to take that one. I can't answer that.

MR. KLEIN: Well, I'll add to that. I guess from our perspective, we don't need to resolve down to the very, very short-term corrosion rates because if you look at the overall testing that was done in WCAP and elsewhere, it is not necessarily the lower pH, very short time duration that provides the bulk of dissolution. It is the higher pHs that tend to release more materials.

And that those tend to evolve over time. And using short term, 30- or 90-minute tests, typically overestimates the amount of say aluminum corrosion because what we saw in ICET and what you see elsewhere on corrosion data, you don't account for oxide formation and passivation of aluminum over time by doing short-term tests. You tend to be conservative.

MR. TREGONING: Now there are counter

examples to that. We know Cal-Sil, for instance, dissolves more readily at lower pH and can dissolve very rapidly. That is something that we demonstrated -- or that is something that we saw not only in ICET but in some of the benchscale testing that we did.

But, you know, the industry has already looked at those. They have done the same tests. They are aware of the data. So the expectation would be that they would appropriately consider those effects as well.

MEMBER WHARTON: And I think when you look at something like Cal-Sil, it is assumed it essentially all dissolves for the amounts that we are talking about are relatively short orders.

MEMBER ABDEL-KHALIK: Thank you.

MR. TREGONING: Okay? If there are no questions, I'll move to the last slide, the summary slide.

Essentially the first bullet, the peer reviewers did identify many chemical phenomena in order, in their opinion, to comprehensively consider chemical effects and make sure that we are adequately resolving those. When we look at closing out generic letter 2000-402, we have completed an initial screening of each of these now -- at least 41 with one additional phenomena. And we are looking to disposition each item.

The ultimate resolution strategy or path will be provided by either existing information that we have to date, ongoing research and evaluations, or additional NRC-sponsored research as appropriate. And I had mentioned that we are considering conducting some scoping analyses for several items to support the evaluation of the generic letter responses by the staff on chemical effects.

Are there any other questions? I know you are anxious to move on to hear some of the industry presentations.

MEMBER BANERJEE: There were no velocity effects identified as being important?

MR. TREGONING: In terms of -- if you could be more specific.

MEMBER BANERJEE: In corrosion rates or things like that.

MR. TREGONING: We certainly discussed that. And that's why I wanted you to be more specific. We talked about velocity effects certainly with respect to corrosion, especially if they were going to be, again, mass transfer or diffusion-limited types of phenomena.

We also talked about the effects of velocity that they might have on -- and this got much more discussion because the effects were deemed to be probably more significant there -- on agglomeration and growth of precipitates that may form. There the effects of velocity were discussed and identified quite rigorously.

So -- but with respect to additional corrosion, while we discussed those, at least the PIRT panelists didn't indicate that they thought that that would be a significant perturbation or significant difference than anything we had done in the ICET testing, for instance, where we had relatively low flow flowing past these samples.

MEMBER BANERJEE: Okay.

MR. TREGONING: Just to ensure that, again, we continually refreshed the solution that was interacting with those plates.

CHAIR WALLIS: So we have here some more work in process. We cannot write a letter or a report saying everything has been resolved to our satisfaction.

MR. TREGONING: Well, you could. But it would be premature.

CHAIR WALLIS: That would be sticking our neck out a little too far.

MR. TREGONING: Yes.

CHAIR WALLIS: Well, thank you, Rob. You have done a very good job. You have actually gained some time.

MR. TREGONING: Anything we can do to get you back on schedule, we'd be more than happy to comply with.

(Laughter.)

CHAIR WALLIS: Well, I was just thinking of your previous reputation in this matter. You have done very well.

The next part of the meeting, I believe, will be closed.

PARTICIPANT: It can be open.

CHAIR WALLIS: It can be open? So we don't need to close this. This is the PWR owners group open meeting.

PARTICIPANT: It is the same subject. But the staff requests --

CHAIR WALLIS: The staff wants their part to be closed?

PARTICIPANT: Yes, so they can present more information.

CHAIR WALLIS: I see. So we will leave

the meeting open --

PARTICIPANT: Wait a minute. What did you say? Okay, so it is entirely open.

CHAIR WALLIS: It is entirely open. So we don't need to close the meeting at all? Thank you. That is good. Let's more ahead.

PARTICIPANT: Our understanding was that we might have proprietary information to discuss although the slide show is not proprietary.

CHAIR WALLIS: Okay.

MR. DINGLER: What we did is we have a lot of slides. We went in and took some slides we wanted to at least emphasize to you. We will go over those. You can ask questions to all or any of the slides we have. And go from there. So we've got some slides picked out that we want to make sure we emphasize to you. And go from there if that's all right with you.

PARTICIPANT: These are the slides here, right?

MR. DINGLER: Yes, those slides there and then we took some slides out to emphasize. And we will go through those. And then you can do whatever -- ask questions or whatever you want.

CHAIR WALLIS: Okay.

MR. DINGLER: We're trying to follow Rob

Tregoning's sparkling example.

CHAIR WALLIS: We will follow what you want to tell us. And then we may ask questions on something we see here that you didn't tell us.

MR. DINGLER: That's correct.

CHAIR WALLIS: Okay. I see an awful lot of words here. Okay. Go ahead.

MR. ANDREYCHEK: Yes, sir, that's true.

CHAIR WALLIS: And you are presenting?

MR. ANDREYCHEK: Yes, I am.

CHAIR WALLIS: Okay. I won't stop you. Go right ahead.

MR. ANDREYCHEK: Okay. Thank you very much, Dr. Wallis.

We'll go to slide two, the objective of this presentation is to review the particular WCAP on voucher efforts, WCAP-16406-P, what its purpose is, its use, and the status of the NRC review. And quickly review application of the methods that plants would be using.

Moving to slide three, the WCAP presents wear abrasion and blockage methods for pumps that are used in ECCS and the containment spray systems, safety related valves, in those systems, heat exchangers, orifices, containment spray nozzles, piping and instrument tubing, and reactor internals.

The fuel will be addressed in a separate WCAP that was alluded to several times this morning. And that WCAP is in draft form and under internal review right now. It is WCAP=16793.

CHAIR WALLIS: Now do these include what we have been calling, I think, thermal gradient effects in the past and heat exchangers in the reactor internals? There is heat transfer going on at the same time. And, therefore, those changes in temperature which can change the soluabilities, and so you can get build up of material as the result of having a hotter occult surface. Is that part of your study?

MR. ANDREYCHEK: That was handled separately from this study. This study was primarily focusing on wear abrasion and blockage.

CHAIR WALLIS: All right.

MR. ANDREYCHEK: So physical sizes of the debris that we --

CHAIR WALLIS: Are you going to talk about the thermal effects today or not?

MR. ANDREYCHEK: Thermal effects --

CHAIR WALLIS: Yes.

MR. ANDREYCHEK: -- in terms of solubility and things plating out?

CHAIR WALLIS: Yes. Heat it up and cool it down and certain things precipitate when you heat them up, some when you cool them down.

MR. ANDREYCHEK: No, I'm not.

CHAIR WALLIS: You are not going to talk about that, okay.

MR. ANDREYCHEK: No, sir.

MEMBER BANERJEE: Are you going to talk about blockage of the core?

MR. ANDREYCHEK: If you drive me to that later in the presentation I will, yes.

MEMBER BANERJEE: But before that you are only going to talk about wear and blockage of valves and pumps.

MR. ANDREYCHEK: That's correct. And heat exchangers. Yes, sir.

MEMBER ABDEL-KHALIK: So you are addressing blockage in the absence of temperature gradients?

MR. ANDREYCHEK: That is correct.

MEMBER ABDEL-KHALIK: Okay.

MEMBER BANERJEE: You have only -- you have some slides of the core inlet, right?

MR. ANDREYCHEK: That is correct, sir.

MEMBER BANERJEE: So we hope to get there.

CHAIR WALLIS: Yes, we'll get there.

MR. ANDREYCHEK: Yes, sir, we will.

MEMBER ABDEL-KHALIK: But aren't temperature gradients sort of a dominant parameter that would effect precipitation and, therefore, blockage?

MR. ANDREYCHEK: Well, first off, we are in the process of evaluating precipitation in general in the reactor core as part of WCAP-16793, which I referenced on the fuel. And we are evaluating that. I'm not prepared to discuss that in any detail today.

With regards to precipitation and formation on other components like the downcomer region, we don't see -- that is such a wide open area, we don't see that that is a challenge. We're talking about inches as opposed to --

MEMBER ABDEL-KHALIK: I understand.

MR. ANDREYCHEK: -- quarters of an inch or so.

MEMBER ABDEL-KHALIK: But in places where blockage would be important, temperature gradients would be a significant independent parameter that would effect that rate at which precipitation would take place.

MR. ANDREYCHEK: That is correct. And that is in the core.

MEMBER ABDEL-KHALIK: And that is not covered by your presentation today?

MR. ANDREYCHEK: Not today. That is correct, sir.

MEMBER ABDEL-KHALIK: Thank you.

CHAIR WALLIS: But it will be in the future?

MR. ANDREYCHEK: It is being addressed in WCAP-16793, which, if you look at the bottom of page -- slide 3, it is the fuel, in general.

CHAIR WALLIS: Okay.

MR. ANDREYCHEK: That is where it is addressed.

MEMBER BANERJEE: And when is that going to be available?

MR. ANDREYCHEK: That WCAP --

MR. DINGLER: Mike Scott says I'm committed to submit that 11:59 on May the 31st.

MR. ANDREYCHEK: Of this year.

MR. DINGLER: Of this year.

CHAIR WALLIS: So things are going to get very interesting later this year when all this stuff comes together.

MR. ANDREYCHEK: Yes, they will.

MEMBER BANERJEE: And when will we get to see that?

MR. DINGLER: You've got to ask the NRC. I can't answer that.

MEMBER BANERJEE: I guess after the staff has had a shot at it, right?

MR. DINGLER: Correct.

MEMBER BANERJEE: Which will be --

MR. DINGLER: We expect to see it sometime in June will be our first time to look at WCAP-1793.

MR. UNIKEWICZ: I'm Steven Unikewicz. And I'll be the lead reviewer or one of the lead reviews for 16793. We expect to see that early in June. Once we see it -- and we haven't -- we've seen it in bits and pieces and parts -- it will become available some time after that.

MEMBER BANERJEE: So we may expect to see it in what September or October?

MR. UNIKEWICZ: We expect to see it long before that.

MEMBER BANERJEE: You expect to but when would we see it?

MR. UNIKEWICZ: Let me talk to Mike Scott. When it becomes available, we will see what we can do.

MEMBER BANERJEE: Okay.

MR. UNIKEWICZ: Okay? I don't have an answer but I can get one.

MEMBER BANERJEE: I guess there is a lot of interest in this.

MR. UNIKEWICZ: Understandably.

MEMBER BANERJEE: So but we are quite happy to see it after you have done your --

MR. UNIKEWICZ: Sure.

MEMBER BANERJEE: -- evaluation.

MR. UNIKEWICZ: We'll talk a little bit about our method of review and things we are looking for when it arrives in a few minutes.

MEMBER BANERJEE: Okay.

MR. ANDREYCHEK: Thanks, Steven.

The first part of the evaluation for wear and abrasion and erosion on pumps, valves, and heat exchanger internals --

PARTICIPANT: Which slide are you on?

MR. ANDREYCHEK: I'm sorry, I'm on slide four. We look at what we call a debris ingestion calculation and we look at the debris sources, where they come from, fibrous debris, particulate debris, and coatings. And these, of course, are plant specific based on the plant specific debris generation calculations. And they form the basis for the debris concentration that is ingested and evaluated for wear and abrasion and erosion.

CHAIR WALLIS: But aren't wear and abrasion is usually due to hard particulates?

MR. ANDREYCHEK: That is correct.

CHAIR WALLIS: So I think you are really talking about certain aspects of the latent debris and maybe the RMI? And are there any coatings that are hard enough to do any wear and abrasion?

MR. ANDREYCHEK: Well, let me back off just a little on that. We will get to that. But there was some testing that was done by Westinghouse back in the `70s that looked at a combination mix of fiberglass, concrete dust, and epoxy coatings. And it made no attempt to try and differentiate between the abrasive capabilities of any of the three. And looked at overall abrasion.

So for the purposes of this calculation, we considered all there sources of debris for erosive capability.

MEMBER BANERJEE: You are going to tell us what you found, correct?

CHAIR WALLIS: Yes, you are going to tell us what you found.

MR. ANDREYCHEK: Yes, we will.

CHAIR WALLIS: You are going to talk about wear and abrasion. Is this an important part of the whole story? Or can we move quickly through it?

MR. ANDREYCHEK: We can move fairly quickly through it.

CHAIR WALLIS: Because isn't blockage more important than wear and abrasion? Or not? No?

MR. ANDREYCHEK: Well, it's --

CHAIR WALLIS: Abrasion is significant?

MR. ANDREYCHEK: It is a significant issue and I think we need to pay a little bit of attention to it particularly on the pumps.

CHAIR WALLIS: Is it because it damages the seals or does it actually damage metal parts?

MR. ANDREYCHEK: Well, it is on the pumps themselves and the rotating surfaces.

CHAIR WALLIS: Is it the seals that it grinds up or is it the metal parts of the pump?

MR. ANDREYCHEK: Both.

CHAIR WALLIS: Both, okay. You're going to tell us.

MR. ANDREYCHEK: Yes.

CHAIR WALLIS: Go ahead.

MR. ANDREYCHEK: Okay. For the purposes

of the discussion, if we can skip past slides five, six, and seven, which deal with more details on debris ingestion, you'd mentioned a little bit about vessel blockage evaluation. I wanted to just briefly touch on that before we get into the wear and abrasion discussions.

MEMBER BANERJEE: So when you talk of debris ingestion, it means stuff that gets through the strainers?

MR. ANDREYCHEK: That is correct.

MEMBER BANERJEE: So they are pretty fine stuff.

MR. ANDREYCHEK: Potentially.

MEMBER BANERJEE: Okay.

MR. ANDREYCHEK: Potentially.

Now I would ask you to remember that this was written -- this WCAP was written approximately two years ago prior to sump screens being redesigned. And at the time, some of the debris sizes could be on the order of an eighth of an inch going through sump screens.

CHAIR WALLIS: And we hope it is not bits of broken strainer when the load on them gets too big.

MR. ANDREYCHEK: I would hope so also. But, you know, certainly with the current strainer design, with maximum sizes on the order of a tenth of an inch of hole penetration, we are dealing with fairly fine debris that gets through the strainer.

CHAIR WALLIS: Unless it is lined up just right to go through.

MR. DINGLER: That is correct. And in the next presentation from the utilities, you will see some of that information of actual SEM data that shows how small and how short they are.

MR. ANDREYCHEK: We're looking at the vessel blockage, we look at pinch points, the minimum dimensions for flow through the system. And this is everything outside of the core. And we look for the entire system.

CHAIR WALLIS: Now when you think about what gets through the strainer, I think in some of the experiments there is a blow-through phenomenon or something where you make the layer and then it blows through the hole. I forget what they call that. But presumably when it blows through the hole, it blows off a piece of felted-type material rather than individual fibers.

So you get chunks of felted material conceivably coming --if there is blow through of individual holes. It is already being sort of pushed together in the screen. And then pushed through the screen as a hunk and rather sort of little pieces, you know, as a little piece of felt.

MR. DINGLER: I think there is one vendor that showed some of that and they had to do some different things. Steve can speak for that. But some of the screens that we are seeing made by some of the vendors so that doesn't happen. You don't have enough --

CHAIR WALLIS: It does happen in some of the horizontal screen tests.

MR. UNIKEWICZ: Let me -- and I don't want to jump in on your presentation.

MR. ANDREYCHEK: Go ahead, Steve.

PARTICIPANT: Can you just comment on the bore holes for a second, Steven, I think that is what Dr. Wallis is asking about.

MR. UNIKEWICZ: Well, actually I have a better answer because I'll tell you -- let me finish and then you can jump in, okay? Bear with me because understandably a lot of these discussions with technical folks -- and unfortunately Tim wasn't part of the discussions this morning nor Maurice.

With regard, most of the licensees right now aren't even considering that. The vast majority are looking at the latent debris or they are looking at their initial walk downs and they are assuming 100 percent pass through. So a lot of the discussions when we talk about worm-holing, talk about pass through through the screens, from the perspective of downstream equipment evaluations, it is not even being considered.

CHAIR WALLIS: They are going to assume that the --

MR. UNIKEWICZ: Right now they --

CHAIR WALLIS: -- grinding powder all gets through.

MR. UNIKEWICZ: It all gets through.

CHAIR WALLIS: Wow.

MR. UNIKEWICZ: A lot of the basis for this WCAP, as you listen to Tim and go through this, a lot of the screen penetration tests, there are a handful of utilities that are considering using that. You will understand -- that's one of my points on my presentation that is a challenge because we are looking at their testing.

The vast majority of licensees right now are assuming that anything ten percent larger than the hole goes through. A four-to-one aspect ratio from a particulate standpoint goes through. A hundred percent of the latent debris goes through. And that forms their basis for their input to start of their component level evaluation.

CHAIR WALLIS: So lots of RMI would get through?

MR. UNIKEWICZ: RMI smaller than the hole. Again, that input is taken from -- we are using those input parameters from other testing. So as the folks that are doing the RMI testing and they say that particle size distribution is XYZ, that particle distribution size, if it is less than ten percent of the hole opening, 100 percent of that assumes to go through.

Again, if you think about it in a different way, if I have a half-inch hole and I'm saying a three-quarter inch piece makes it way through, it seems like it is a reasonable assumption along those lines. So we can talk about worm-holing, we can talk about a lot of things but recognize that that is the exception rather than the rule when people are physically doing these evaluations.

MR. ANDREYCHEK: Thank you.

CHAIR WALLIS: So you have got to be very conservative then.

MR. ANDREYCHEK: That's correct.

MEMBER BANERJEE: That is probably because it doesn't matter, right, in this case?

MR. ANDREYCHEK: No.

CHAIR WALLIS: Well, we are going to hear about that.

MR. ANDREYCHEK: That is not necessarily true.

MEMBER BANERJEE: It is not necessarily true?

MR. ANDREYCHEK: No, it is not. It does matter.

MEMBER BANERJEE: In which case you will become less conservative?

MR. UNIKEWICZ: Those folks that are redoing their evaluations and looking at the actual screen testing are those folks that failed the first time through. So when they attempted to do it with 100 percent pass through with those conservative assumptions they didn't make it.

By didn't make it, they mean they decided they either plugged downstream components or their wear rates within rotating equipment were such that there was an instability in the pump and they needed to reevaluate and use the modifications.

Once they flunked that, now they refined their approach. And the refining of the approach has to do with bypass testing. And all five different vendors have a slightly different approach.

Not jumping ahead to my presentation but that is truly one of the challenges to look at what assumptions they are now making based upon their actual configuration of their screen design. But, again, that is the exception rather than the rule at this point in time.

CHAIR WALLIS: Okay. So we will go back to the owners group.

MEMBER ABDEL-KHALIK: Thanks, Steve.

MR. ANDREYCHEK: Now the vessel evaluation, once again, was looking for what were our pinch points were at and where it might block in the vessel outside of the core. Slide nine briefly identifies the things that we were looking at, the areas we were looking at. And the graphic shows the areas that --

CHAIR WALLIS: Are you going to give us results of what you looked at? Or just telling us you are looking at it?

MR. ANDREYCHEK: We can give you results. We looked at the downcomer and the region between the upper core plate and the neutron panel. We looked at upper support plate and then the guide tube assemblies and support columns. We looked at the lower plenum and typically the areas --

CHAIR WALLIS: Have you made predictions or did you do experiments of some sort?

MR. ANDREYCHEK: Actually we looked physically at them using drawings, plant drawings, as constructed drawings. And looked at the debris size that would fit through the sump screen, compared it to the clearance sizes, and in the cases that we looked at, the clearance sizes were on the order of five to eight times larger minimum than the debris that fit through. And typically they were much more -- they were over 20, factor 20 or greater clearance.

CHAIR WALLIS: Do you have all the fuel support grid things, the things that are in the actual -- around each fuel element? Those weird shaped things that --

PARTICIPANT: The P grids?

MR. ANDREYCHEK: Are you talking about support grids where you have the egg-crate design?

CHAIR WALLIS: They are a very unique kind of design.

MR. ANDREYCHEK: That's correct.

CHAIR WALLIS: Are you looking at that,

too?

MR. ANDREYCHEK: That's, again, part of the core evaluation.

CHAIR WALLIS: So you are looking at it?

MR. ANDREYCHEK: Yes, yes.

MEMBER KRESS: Is your criteria the pinch point area being substantially bigger than the biggest part of the design?

MR. ANDREYCHEK: That is correct.

MEMBER KRESS: Well how much bigger does it have to be?

MR. ANDREYCHEK: We were looking -- what we found in looking at design drawings was that the tightest pinch point was on the order of about eight times larger than the eighth inch particle.

MEMBER KRESS: Is that sort of a representative diameter of the pinch point?

MR. ANDREYCHEK: It is actually clearances when we walked around the reactor vessel outside of the core. Again, I want to stress that we didn't look at the core for this particular part of the evaluation. This was in the reactor vessel proper, the upper internals, the lower internals.

The flows in those regions are designed to provide flow straightening in the lower plenum but they are fairly wide open. But we needed to confirm that.

MEMBER KRESS: And your belief is that sort of situation won't plug up?

MR. ANDREYCHEK: That is correct.

MEMBER KRESS: And how do you know that?

MR. ANDREYCHEK: The flow clearances are sufficiently large enough that they won't physically grab in there. I mean if you have a two-inch diameter hole and you have a tenth of an inch --

MEMBER KRESS: Well, I am aware of cases where small debris plugs up big holes. Abridging, eventually building up little layers on the side and eventually --

CHAIR WALLIS: If it is sticky, if it is at all sticky.

MEMBER KRESS: If it is sticky.

CHAIR WALLIS: Right.

MEMBER KRESS: So I'm not so sure I can buy your criteria. Of course, it is a start. I am aware of cases where big pipes have plugged up with very small debris building up over time. This requires time and sufficient sources of stuff to continue. But anyway, I'm not so sure your criteria is exactly one we could buy into.

MR. ANDREYCHEK: Okay. Understood.

MEMBER BANERJEE: But that was what you did.

MR. ANDREYCHEK: That is correct.

With regards to slide 10 --

CHAIR WALLIS: Well, in the extreme case, I mean if you have a drain from your kitchen sink and you put fats down there and form little small globules, eventually you may get a plug which fills the whole thing.

MEMBER KRESS: Yes, it depends on the flows and the stickiness.

CHAIR WALLIS: Yes.

MR. ANDREYCHEK: Okay. Slide 10, we'll move on to pumps. And I've got several slides that show the different types of pumps that are typically in use. We are looking at debris depletion.

And over time, the debris, we believe, will deplete because of settle out in different areas of the recirculatory system, some of the evaluation criteria which Steve alluded to previously and potential plugging.

Slide 11 is a typical --

MEMBER BANERJEE: I'm sort of interested in this issue of settling out. How will you figure out where it settles and how much settles? Is there any attempt to do that?

MR. ANDREYCHEK: The attempt that we looked at was to settle out in the lower plenum of the reactor vessel. We assume no other settle out anywhere else for these evaluations, including in the containment sump, which we felt was a very conservative approach.

And the reason we were looking at the lower plenum for settle out is if we got large debris through the sump screen, could we argue -- could we show that it would settle out in the lower plenum and not reach up into the reactor core and potentially cause blockage of flow paths, tight flow paths as alluded to by Dr. Wallis in the complex configuration of the sump screen -- of the fuel.

MEMBER BANERJEE: So I'm just trying to get an idea. Is there not stuff getting through that can actually fill up the lower plenum and then get up to the core?

MR. ANDREYCHEK: That is a good question, Dr. Banerjee. We have taken a look at what can actually get through.

CHAIR WALLIS: We asked you last time you presented. We took your truckloads and we took a portion of them.

MR. ANDREYCHEK: Yes, you did.

CHAIR WALLIS: And it doesn't take much -- a fraction of all those truckloads to fill the lower plenum.

MR. ANDREYCHEK: No, it does not. Although we did do some calculations based on some audit questions that two licensees received. And based on their plant-specific sump screen testing, we showed that they would fill up less than about 15 or 20 percent of the lower plenum given that all the debris that could fit through the screen did get through the screen and did get to the lower plenum.

So in response to your question, based on what we have seen so far from plant-specific testing, no, we would not fill substantial portions of the lower plenum, certainly not to the point that it would fill up and block the entire lower plenum.

MEMBER BANERJEE: So it is not that you are going to get everything smaller than those holes through.

MR. ANDREYCHEK: That is correct.

MEMBER BANERJEE: You are going to get some of it through.

MR. ANDREYCHEK: That is correct.

CHAIR WALLIS: Now is it still undergoing chemical reaction while it is in the lower plenum? Presumably it is. It is still making stuff.

MR. ANDREYCHEK: Typically the material that would get through that would be -- that we would look at would be -- I would say non-reactive debris.

CHAIR WALLIS: So you wouldn't get Cal-Sil through?

MR. ANDREYCHEK: If the Cal-Sil got through, typically when it goes through, it is very fine. It would tend to actually --

CHAIR WALLIS: Go right through the core.

MR. ANDREYCHEK: Yes.

MEMBER BANERJEE: But if it started to get sticky, then it could form --

CHAIR WALLIS: If it was sticky, it might want to stick to the pump blades and things like that because of the separation in the pump throwing it at the wall.

MR. ANDREYCHEK: There are other areas where it potentially could collect at besides that.

MEMBER BANERJEE: Plug up the pump volumes, correct?

MR. ANDREYCHEK: If it were sticky, it potentially could.

CHAIR WALLIS: How sticky is it?

MR. ANDREYCHEK: I have not looked at that. I don't have a way of judging that.

CHAIR WALLIS: Are your surrogates sticky? They're not but they might be in reality.

MEMBER BANERJEE: The stuff that Bill Shack was showing us was real sticky stuff. Wasn't it really sticky that white material in the argon tests?

MR. ANDREYCHEK: I'm not familiar with the argon tests but I can tell you from what I can recall seeing, and I was very deeply involved in the ICET tests that were run at the University of New Mexico, the precipitate material that we formed there, as I recall, was not sticky.

I believe -- is Rob Tregoning still here? What we saw from the precipitants from the ICET tests, and there were five different samples using calcium silicate, fiberglass, as well as sodium hydroxide, TSP, and sodium tetraborate, all of the samples that were pulled over the 30-day period, put in small glass jars, and allowed to settle did have some precipitants that settled out over time.

And if they were stirred, shaken a little bit, it became basically an emulsion. There was no stickiness associated with those precipitants. And that included materials like calcium silicate and fiberglass being in the mix. We had zinc and aluminum panels, concrete panels, and we actually ground up a small amount of concrete dust and threw it in as latent debris.

So from the ICET test, which was a long-term test done at a somewhat elevated temperature of 140 degrees F for 30 days, we saw nothing that I would argue would be something that would agglomerate and hold on to sides of things even with regards to the glass jars. We didn't see that sticking on to it. So I don't know what --

MEMBER BANERJEE: Did the ICET test, that white stuff that came out in the pipes, what was that? It seemed to form a --

MR. ANDREYCHEK: There was a test that did have some material that actually fouled a turbine --

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: -- flow meter.

MEMBER BANERJEE: Was it a flow meter?

MR. ANDREYCHEK: It was a flow meter. And there was some white material that did settle on the pipes. Now I was there when they shut down one of the tests.

And it is unclear that that actually

formed during the running of the test or formed when they were cooling the facility down and draining the test down. We did not -- to my way of thinking, I couldn't tell what it was. And so to my way of thinking, I didn't see anything that really stuck.

MEMBER BANERJEE: And the flow meter, what happened there?

MR. ANDREYCHEK: I was not there when the flow meter was pulled out. But my understanding was is that some material had formed on the rotating element and caused it to freeze.

MR. KLEIN: I just wanted to add to what Tim had said, Paul Klein from NRR, we didn't really see evidence of -- if you want to describe it as sticky -- it almost had a consistency of face cream is how it was described.

But during the Cal-Sil TSP test, as Tim described, on about Day 8, the flow meter did stop working and we pulled it out at that point. And it had probably a combination of very fine Cal-Sil particles and also calcium phosphate precipitate on the material at that time.

MEMBER BANERJEE: And was it a creamy consistency? Or what was it like?

MR. KLEIN: I was not there when they

physically removed it. But that was my understanding that it was a creamy consistency.

MR. UNIKEWICZ: Let me put in perspective again -- 500 horsepower pump, roughly 1,800 RPMs, some 3,600 RPM. Tip speeds on the order of a few thousand feet per second. Things that we have seen from a chemical standpoint are not -- they are going to pass through, at least from a chemical perspective, by your pump impeller and through your pump even on a single-stage low-pressure injection pump.

Okay, again, on the order of 300 to 500 horsepower motor massive tip speeds, very quick tip speeds, these chemical effects are not going to stop.

MEMBER BANERJEE: We were talking about the volute.

MR. UNIKEWICZ: I understand.

MEMBER BANERJEE: Yes.

MR. UNIKEWICZ: Even collecting on the volute, okay, and the turbulence that is inside the volute as you go through, it is not going to collect. It is not going to stick although it may be sticky and I'll say relatively speaking low velocity situations inside the volute, extraordinarily turbulent situations, it is not going to stick to a stainless steel casing. It is not going to stick to a stainless steel --

CHAIR WALLIS: Well, one way to look at flow patterns in a pump is to throw a can of paint into it. And you certainly see on the surface the stream lines.

MR. UNIKEWICZ: That is correct. And it will pass through.

CHAIR WALLIS: Because, you know, there is paint left on the blade. It is not as if it all disappears.

MR. UNIKEWICZ: Correct. But it doesn't agglomerate to the point where we are going to stop --

CHAIR WALLIS: Probably not.

MR. UNIKEWICZ: I understand your question and really we worked through that question early on during the chemical effects discussions. And as soon as that came out, that was one of our concerns. And that was a very early question we had two or three years ago. So we did work through that.

CHAIR WALLIS: I think the concern with plating is more when you got temperature -- if you've got really hot fuel, the stuff comes along and melts on the fuel.

MR. UNIKEWICZ: Right. This would be more of a fuel question rather than a pump impeller. Or even from a heat exchanger perspective.

CHAIR WALLIS: Right, right.

MR. UNIKEWICZ: It is less of a heat exchanger perspective.

MEMBER BANERJEE: Well, it is any point where there might be a vortex of some sort where you might trap something for a while, whether it is a pump, whether it is a valve, whether it is an elbow, wherever there is a separation region, that would be the concern.

And I am assuming that the material that gets through is probably not of large enough quantities that it would do that. But I don't know that.

MR. UNIKEWICZ: Not from a pump perspective certainly.

MEMBER BANERJEE: Yes, a pump is very unlikely. It is forcing things through as long as it is running.

MR. UNIKEWICZ: That's right.

MR. ANDREYCHEK: I understand.

MEMBER BANERJEE: All right.

MR. ANDREYCHEK: And again, slides 11, 12, and 13 are --

CHAIR WALLIS: Are you going to accelerate through these?

MR. ANDREYCHEK: Yes.

CHAIR WALLIS: I'm sorry.

MR. ANDREYCHEK: It's okay. Slide 14 is an example of abrasive wear for three different types of materials.

CHAIR WALLIS: As an experiment or as a model?

MR. ANDREYCHEK: No, it is actually correlations from industry, industry practice. This is what it looks like.

CHAIR WALLIS: It looks pretty slow.

MR. ANDREYCHEK: Pardon?

CHAIR WALLIS: It looks like a pretty slow rate, isn't it?

MR. ANDREYCHEK: That's true. And that is based on three different types of materials and debris concentration by weight. This is what you can expect in terms of wear and abrasion at least on --

CHAIR WALLIS: Is this significant for your problem?

MR. ANDREYCHEK: It is useful information to start with.

Slides 15 and 16 --

MEMBER ABDEL-KHALIK: Excuse me.

MR. ANDREYCHEK: Yes, sir.

MEMBER ABDEL-KHALIK: What other parameters, other than the debris loading parts per million, effect the results of the abrasive modeling?

MR. ANDREYCHEK: The flow rate, how fast the water is flowing.

MEMBER ABDEL-KHALIK: How about the characteristics of the particles themselves?

MR. ANDREYCHEK: Again, we were using an agglomerate of materials that were tested based on three different types of materials. We didn't deal with -- at least initially in the initial screening process --

MEMBER ABDEL-KHALIK: What quantitative physical property of the debris enter into the calculation of the abrasive wear model?

MR. ANDREYCHEK: It is my understanding that the physical property was an aggregate or an average abrasiveness associated with the debris. I'm not sure how else to put it.

MEMBER ABDEL-KHALIK: Is it a hardness number? Is it a density?

MR. ANDREYCHEK: I think it was --

MEMBER ABDEL-KHALIK: What property enter into this quantitative model?

MR. ANDREYCHEK: I can't answer that right now.

MR. UNIKEWICZ: I'll answer the question.

MR. ANDREYCHEK: Go ahead.

CHAIR WALLIS: Well, is it predictable also?

MR. UNIKEWICZ: The answer to a lot of -- again, I'll kind of jump ahead. I talk about this a little bit. Right now --

CHAIR WALLIS: We're going to cut down on your presentation.

MR. UNIKEWICZ: That is quite all right with me.

But the significant point of discussion, I'll say right now, between staff and the owners group is, in fact, the abrasive versus the erosive wear models. The key inputs to that abrasive wear model are yes, Brunell hardness of both pump internals, the Brunell hardness, the hardness materials of the latent debris and how it effects.

The chaff loading, DP across from a stage to stage standpoint, all those things are inputs. The interesting thing about looking at debris as it passes through the system and, Dr. Wallis, you recall seeing our little curve at CCI, that peak loading of pass through is the area of concern from a pump evaluation.

So yes, parts per million, abrasiveness of material, hardness, quantities, DP across a stage, all those have an impact on that wear rate calculation and effectively the pump models, if you will, the rotor dynamic models.

If I look at a valve evaluation, it is abrasiveness and PPM and speed seven to ten feet per second or so from an erosive standpoint. When I look at vessel evaluations, it is the area under the curve for all that stuff.

MEMBER ABDEL-KHALIK: The question really was driving at whether or not you have any chance of predicting in an a priori manner what those relevant physical properties are for the range of debris that would be expected?

MR. UNIKEWICZ: Yes, I believe there is. And the reason I say that is a couple, one is there are, from a slurry calculation standpoint, Archin model, there are a few other calculational methods that are very well defined in the tribological world. So these types of calculational methods are very common, I'll say, outside the nuclear industry.

We have -- or there has been a presentation of different hardness for all the latent debris. And we have asked the questions of the silicas, the rust, the dirt, you know, Brunell hardness of that. It is very well documented, the hardness of the stellite 6, stellite 12 wear rings within the pump internals, those type of comparisons are probably the most key comparisons within these evaluations.

Understand it is a two-step process. One is you calculate wear rate. The second thing after you calculate wear rate, now I'm looking at pump instability. So it really is a two-pronged approach.

The very short answer is yes, we have fairly well documented material properties. We have some good calculational methods that currently the owners group and staff are going over. So all of those inputs that you are talking about are included.

Now it is not included in the one that you will see here but it will be included in the Rev. 1 to the WCAP.

CHAIR WALLIS: I'd like to move on from this subject because there is a lot more --

CHAIR WALLIS: -- that is interesting, isn't there?

MR. ANDREYCHEK: I gather from your comment, you found something you have particular interest in so we can move on. Say again?

PARTICIPANTS: Orifices.

MR. ANDREYCHEK: I just want to point briefly on page 18 and 19 is the success criteria for the pumps wear and abrasion. And 19 contains a flow diagram of doing the evaluation.

CHAIR WALLIS: This is something of concern? We have to worry about pump abrasion in considering this problem? Or is it a red herring we do have to worry about.

MR. ANDREYCHEK: We do have to worry about it.

CHAIR WALLIS: What we need to remember is we need to revisit it.

MR. ANDREYCHEK: Right, exactly.

CHAIR WALLIS: Thank you.

MR. ANDREYCHEK: And the same is true on slide 20. It is another flowchart of how to do the evaluation.

Moving on to orifices, this is erosive wear. A similar type of checklist of items to look for. And on slide 22 is a couple of examples of orifices. And slide 23 would be the checklist for what you would need to assemble to do an orifice evaluation.

MEMBER BANERJEE: What about orifices? Is there something that we have to worry about orifices here?

MR. ANDREYCHEK: Yes, there are.

MEMBER BANERJEE: What happens to them?

MR. ANDREYCHEK: Well --

MEMBER BANERJEE: Or are you coming to that?

MR. ANDREYCHEK: Well, what can happen to them, particularly in the ECCS system under certain conditions in the high hot head systems, there are flow balancing orifices for the purposes of assuring delivery, relatively equal delivery to the different points of injection.

And wear and abrasion on these could throw that balancing out of whack and might cause you some problems. The acceptance criteria is a change in flow rate over the nominal flow rate of less than three percent.

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: Okay.

MEMBER BANERJEE: But if that happened, compared to blocking up the core or something, is this a major issue?

MR. ANDREYCHEK: It is potentially an

issue of loss of ECCS flow, yes.

MEMBER BANERJEE: It is?

MR. ANDREYCHEK: Potentially reduce the ECCS flow below the desired limits to maintain a coolable core. So, yes, it should be considered.

MEMBER BANERJEE: Let me understand it. You have these orifices but the fact that one become bigger than the other due to wear or something, it diverts the flow in some undesirable direction, is that it?

MR. ANDREYCHEK: Potentially, yes.

MR. DINGLER: The other one is we have to look at if we change the flow balance, which changes the flow and changes the head of the that pump, we might be at run off on the head of that pump so we've got to look at that and make sure we don't go past the runoff on the pump curves.

MEMBER BANERJEE: Okay. That's more sensible.

MR. DINGLER: In other words, we will get enough flow but we might take the pump above the pump curves.

MEMBER BANERJEE: Yes, okay.

MR. ANDREYCHEK: Slide 25, plugging evaluation --

MEMBER BANERJEE: So these orifices basically throttle down --

MR. DINGLER: What they are doing is equalize the head loss in each leg so say in a four looper, you have equal injection in all four legs. And they are adjusted by a massive flow balance. And you put them in and you take them back out. And you put them in and make sure you flow balance.

MEMBER BANERJEE: Thank you.

MR. DINGLER: And then you do some throttling of the valves to help on that, too. There are throttle valves on that, too.

MEMBER BANERJEE: So this could be actually a real problem because the orifices might actually erode.

MR. DINGLER: There is a potential and you have got to look at it and evaluate will they erode too much and will they not, yes.

MEMBER ABDEL-KHALIK: Where are these orifices exactly? Which orifices are we talking about?

MR. DINGLER: For some plants, they are put in in front of the injection flows so they don't have to throttle their throttle valves down so tight. And the flow balance for going into the RCS from the charging and the high head pumps.

MEMBER ABDEL-KHALIK: Okay. So you are looking at the difference between the effected loop and the unaffected loops?

MR. DINGLER: In other words, I'll speak for a four looper, we eject -- we have the ability to eject in all legs. So in other words, you flow balance your throttle valves and that to the injections based on loss of head.

So in other words, some plants have so not to throttle their valves as tight, they put flow orifices in and open their valves to reduce the flow or to increase the head so that it will adjust the flow so it is equal.

MEMBER ABDEL-KHALIK: Okay. Thank you.

CHAIR WALLIS: Now this slide here, Los Alamos did some experiments with RMI and valves.

MR. DINGLER: That's correct.

CHAIR WALLIS: It is a bit surprising how they did actually get some plugging even though the product holes were fairly small.

MR. DINGLER: Based on Los Alamos, they went ahead and ejected -- my understanding, Dr. Wallis, they slug load into the valve and see how much it took of a slug load to plug a valve.

CHAIR WALLIS: But this sort of rule of thumb that if the orifice is four times as big as the sump screen size, it seems to me a little unconservative. I mean it is of an assumption which is in the best of all possible worlds, this is true. But is it really true?

MR. ANDREYCHEK: What slide are you on? Sorry?

CHAIR WALLIS: I was looking at what was up there.

MR. ANDREYCHEK: I know I missed it.

CHAIR WALLIS: Twenty-five.

MR. ANDREYCHEK: Yes, 25.

CHAIR WALLIS: It seems to me this has to be verified by experiment or something rather than just assuming.

MEMBER BANERJEE: Is it plugging we are talking about or where?

MR. ANDREYCHEK: This was plugging.

MEMBER BANERJEE: We were talking wear.

MR. ANDREYCHEK: We were talking wear. This is a plugging issue.

CHAIR WALLIS: Well, you see if the RMI is sort of gathered together somewhere and then came down as a group of RMI, it could conceivably plug the orifice. I think this is sort of an assumption that looks a little hopeful.

MR. ANDREYCHEK: Well, I'm not sure that I would agree with that outright. And let me explain the reason why. These orifices are downstream of the pump.

CHAIR WALLIS: Yes.

MR. ANDREYCHEK: So if the debris is going to get to this orifice, it needs to go through the pump. And, again, we are dealing with high head SI pumps and charging pumps, which are multi-stage pumps, very tight tolerances.

CHAIR WALLIS: So it is going to be chopped up?

MR. ANDREYCHEK: Yes, sir. Or my pump is plugged up and I don't have to worry about it. Or the pump won't function, one of the two. The orifice will be fine but the pump may have a challenge.

MEMBER ABDEL-KHALIK: Might have a challenge, correct.

CHAIR WALLIS: Well, the staff is going to settle this out isn't it?

MR. ANDREYCHEK: Yes.

CHAIR WALLIS: Okay.

MEMBER ABDEL-KHALIK: I mean it just

doesn't make much sense. Are there any orifices downstream of these safety injection pumps that are in the order of an eighth of an inch diameter?

MR. ANDREYCHEK: I can't answer that from a plant by plant basis. I can't say for sure one way or another.

Mo, do you know what the size of the orifices are?

MR. DINGLER: It is very plant specific. And I can't answer that.

MR. UNIKEWICZ: I can answer that. Okay. A couple things. One is you need to put this in perspective. And part of the perspective is the assumption right now is 110 percent of something larger than the screen is going to make its way through, okay.

And the way this evaluation works, right now so initially you are assuming something 110 percent bigger than the screen size. When you get down to this piece of the evaluation here, you now kind of limit that a little bit smaller and say well, gosh, even if 110 percent went through, a smaller piece may or may not plug it.

From a practical standpoint, the issue is -- from a practical perspective it is not orifices.

Orifices tend to wear away and it becomes a pump run out issue more than anything else.

Throttle valves, and there are any number of throttle valves which are on the order of a tenth of an inch openings, those particular plants for the most part are making modifications. And the way they are making their modifications there are a couple, three ways.

One is they are changing throttle valve sizes. They are putting something with a more open ported valve. The other thing that they are doing is a combination of that an adding upshuring orifices so that they are allowing upshuring orifices to take some of the pressure drop before you get to the throttle valve.

The third thing that is happening is there are a number of plants that have DP gauges across throttle valves. And they have downstream flow indication. If you are watching downstream flow indication, and are sure that you have flow and you have the ability within your EOPs or your AOPs to open up a valve, by opening up the valve it flushes what is there through.

Now when you talk back to that LANL report, the LANL report, in effect, said things the same size or smaller plug it -- or larger plug it. Things smaller go through. And the amazing conclusion that if I open up a valve larger, things that are caught in it likely will flow through because I'm looking at anywhere between say five to 15 feet per second.

So that assumption is in an of itself I'll say a realistic assumption. And recognize that when you -- when I'm looking at my source term, my source term can't get that small anyways. So you have to sort of look at them at the same time.

MEMBER BANERJEE: That report, if I remember, had some curious results in it.

MR. UNIKEWICZ: It did.

MEMBER BANERJEE: Yes.

MR. UNIKEWICZ: It had some interesting results.

MEMBER BANERJEE: That piece of argon got caught in a vortex or something in the pump and then sat around and blocked things.

MR. UNIKEWICZ: Yes, the pieces and parts don't get chopped up in these pumps.

MEMBER BANERJEE: Yes.

MR. UNIKEWICZ: They don't. They will pass through. They are fairly wide open. Even thought there are tight clearances for all intents and purposes, the material that is not caught in a 10- to 12-mil spot in the shaft are going to pass through.

Nobody is taking credit for collection of debris within the pump. And we're not going to allow that even if they tried to, okay. Everything passes through.

Then you will look at, again, three different evaluations from a downstream standpoint, an erosive, a plugging, and an abrasive.

MEMBER BANERJEE: So what sort of valves are these throttle valves?

MR. UNIKEWICZ: Typically globe valves. There are some other style valves. There are some cage valves. There are some dragflow valves from different vendors.

MEMBER BANERJEE: So if they were globe valves, for example --

MR. UNIKEWICZ: They are, in effect, globe valves with very tight clearances. And, again, those people with a tenth of an inch or so openings, they are evaluating that. In a lot of cases they are doing, again, one of three things: adding orifices and looking at whether they have instrumentation to throttle if they can. Or in a case -- one of the extension requests are that they are redesigning the valve so that they have a more open style body while maintaining that proper flow balance and opening up a little bit to let things pass through.

MEMBER BANERJEE: It must be quite a trick.

CHAIR WALLIS: Are we talking about all this so we'll never get to the core? Is that all this is?

MR. UNIKEWICZ: That is the more fun part anyway. This is the more interesting part. The core is the core. It is more fun to talk about this.

MEMBER BANERJEE: Is that what you want to present to the full Committee then? This stuff?

MEMBER KRESS: But once again, I want to refer you to some work done by EPRI in the mid-80s. I don't recall the reports or the title. But one of the authors was a fellow named Morawitz. That's about all I can remember. But the subject was what would happen with the holes in containment in aerosols, which is a similar issue.

Their contention was that these aerosols would plug up these holes. Although the holes were big and aerosols were small. So they ran a series of tests to validate that contention. And sure enough, they plugged them up. So , you know, these are small things plugging up big holes.

MR. UNIKEWICZ: You are correct. There are also some service water systems on rivers and ponds that have silt meaning we have seen them pass six-inch lines. Now granted, as you mentioned, it is a long period of time. Service water lines, this was in a matter of 15 years that they did plug up with silt.

MEMBER KRESS: Well now Morawitz and Company ere concerned about containment. And that is a smaller pie.

MR. UNIKEWICZ: Understand. But I will look into that.

CHAIR WALLIS: Okay, let's move on.

MR. ANDREYCHEK: Okay. If it is acceptable, we'll look at slides 26, 27, and 28, and 29, which are all heat exchangers.

CHAIR WALLIS: But there is no heat transfer effect you are looking at here so --

MR. ANDREYCHEK: No, there isn't.

CHAIR WALLIS: And they don't plug, do they?

MR. ANDREYCHEK: No, they do not. The velocity within the --

CHAIR WALLIS: So then we can just move on with no problem?

MR. ANDREYCHEK: Yes. We also looked at a erosive wear and heat exchanger is not a problem plugging. The same --

CHAIR WALLIS: Well, now we've got some valves here.

MR. ANDREYCHEK: And, Dr. Banerjee, you had asked about what are the different types of valves, if you take a look at slide 33, there are several different types of valves that are --

CHAIR WALLIS: If they plug, you just open them up, is that what you do?

MR. ANDREYCHEK: Well, you --

CHAIR WALLIS: If you know they have plugged, you can open them up.

MR. ANDREYCHEK: I don't know that you can open them up in the plant. Some of these might be locked in position. Most specifically, some of the ECCS valves.

MR. DINGLER: It depends on the location. Some of them you can access. They are high radiation.

CHAIR WALLIS: That is kind of self-defeating. I mean you make a pump to pump water in and then you make it pump through a tiny little hole so it is more difficult for the water to get in. It's very strange. But anyway.

MEMBER BANERJEE: Let's talk about debris going through that valve.

MR. ANDREYCHEK: But 34 is similar to what you have seen. Slide 34 is similar to what you have seen before in terms of what you need to do the evaluation.

CHAIR WALLIS: We're still on erosive wear?

MR. ANDREYCHEK: I beg your pardon -- yes, erosive wear.

CHAIR WALLIS: We're still on that subject. Could we go on to something else?

MR. ANDREYCHEK: Sure.

CHAIR WALLIS: Or is there nothing else?

MEMBER BANERJEE: No, the core blockage.

CHAIR WALLIS: Well, their evaluation of blockage at core inlet 41.

MR. ANDREYCHEK: Is that where you would like to go, sir?

CHAIR WALLIS: It sounds good to me.

MR. ANDREYCHEK: Okay.

CHAIR WALLIS: Is that okay with the Committee to do that?

MR. ANDREYCHEK: Fine.

MEMBER BANERJEE: At some point though you will have to explain to me how these many trap loads become less than one plenum load but that is okay.

CHAIR WALLIS: Pull up on the screen.

MR. ANDREYCHEK: We can talk at the break.

For a double-ended guillotine break, the refueling water storage tank or the borated storage water tank can be depleted in approximately 20 minutes. Fibrous and particulate debris can pass through the sump screen. We have seen that.

CHAIR WALLIS: And dissolved chemicals?

MR. ANDREYCHEK: And dissolved chemicals. And there is a potential for build up at the core inlet, particularly at the fuel assembly bottom nozzle. There are some debris-capturing devices that the vendors have put on the bottom of the fuel so it is a tight pinch point.

We had a screening criteria previously. We used an eighth of an inch of fiber that formed on the bottom of the this so the fuel would collect debris. And the objective here was to look at well what happens really.

We took a more detailed look and we went through and looked at the break location. And we choose to use a double-ended guillotine break, boat leg, because it would have the limiting amount of flow that would actually get to the core. It is driven by gravity head in the down flow.

CHAIR WALLIS: So you've only got that head to drive the flow through the core?

MR. ANDREYCHEK: That is correct, sir.

CHAIR WALLIS: All right.

MR. ANDREYCHEK: Okay. We go to slide 43, looking at a plant selection, trying to come up with a model to use, the down-flow baffle barrel regions are the most limiting because the only way you can get water into the core realistically is through the bottom of the fuel. If you have a design that is up flow, there are alternate flow paths where you could get water in part way up the length of the fuel. If it is a converted up flow, there is still another flow path that is close to the top of the fuel.

For the purposes of the evaluations that we did --

MEMBER BANERJEE: This is sort of a bypass part from the top?

MR. ANDREYCHEK: In the down flow, no, there is no bypass. It all has to come -- all the flow has to come through the lower plenum. Any other design --

MEMBER BANERJEE: Okay.

MR. ANDREYCHEK: -- any other design --

MEMBER BANERJEE: There is some bypass.

MR. ANDREYCHEK: -- has some potential for bypass, yes, sir.

Okay. We were using the Westinghouse COBRA/TRAC code to do these calculations, long-term calculations. We used the three-loop pressurized water reactor that had a very high core power density, more limiting and even some of the four loopers that e are familiar with.

The right-hand side is the COBRA/TRAC noting diagram. And the left-hand side shows the schematic of the -- the cutaway to the reactor vehicle itself. And it is there for illustrative purposes.

Slide 45 is the approach we took to doing the computations. We modified the code slightly to identify and allow the users to change the resistance at the entrance to the core, to flow into the core. And that was at the very first set of channels. And that allowed us to simulate, if you would, a blockage. Deterministically, we are going to assign a blockage there and see that happens.

MEMBER BANERJEE: Can you do this some time into the transient?

MR. ANDREYCHEK: That is correct. And if you will, on Slide 46, it describes when we did that. We ran these blockage calculations for up to 40 minutes of transient time. And we allowed the refueling water storage tank to be drained down over the first 20 minutes of the transient.

So it went through a blowdown and drained the refueling water storage tank for up to 20 minutes. Then from 20 minutes to 20.5 minutes, we ramped the loss coefficient at the entrance to the core from the nominal value based on physical characteristics of the geometry of the core entrance itself to a value of one times ten to the ninth, a very large hydraulic loss coefficient.

And for all practical purposes, that simulated complete blockage of those areas that the loss coefficient was assigned to. We also modified the RHR heat exchanger outlet temperature.

MEMBER ABDEL-KHALIK: Let me just understand this.

MR. ANDREYCHEK: Sure, go ahead, sir.

MEMBER ABDEL-KHALIK: Did you -- this assumption of increased loss coefficient at the entrance, was that applied uniformly to all channels at the inlet?

MR. ANDREYCHEK: Bear with me for just a moment and I will answer that question. I have a couple of slides further back. And it shows where we applied it.

MEMBER ABDEL-KHALIK: Okay.

MR. ANDREYCHEK: Okay?

MEMBER BANERJEE: The short answer is no.

CHAIR WALLIS: It can't be if it is applied to everything and nothing gets through.

MEMBER BANERJEE: On page 47.

MR. ANDREYCHEK: It is not applied everywhere but almost everywhere.

CHAIR WALLIS: Almost everywhere.

MR. ANDREYCHEK: Okay.

CHAIR WALLIS: But not .6 percent.

MR. ANDREYCHEK: That's correct.

MEMBER KRESS: The COBRA/TRAC allows cross flow in the core when you --

MR. ANDREYCHEK: That is correct.

MEMBER KRESS: -- when you bypass the blockage.

MR. ANDREYCHEK: That is correct. It does allow for flow redistribution through the open lattice structure of the fuel.

We modified and allowed the water being

ducted into the reactor vessel to go to 190 degrees Fahrenheit, which is the --

MEMBER BANERJEE: But in a COBRA/TRAC, the cross flow channel -- because this is basically a parallel channel core, is based on really fairly high flow rates. And I wonder if it can really be applied to these very low flow rates that you are talking about because it actually mixes by turbulent mixing. Maybe somebody looked at that. Who ran this? Somebody who --

MR. ANDREYCHEK: This was done by Mitch Missley and Kevin Barber, both out of the LOCA analysis group. You may be familiar with Mitch Missley.

MEMBER BANERJEE: Yes, the problem is, as you know, it is primarily used for fairly high --

MR. ANDREYCHEK: That's correct.

MEMBER BANERJEE: -- flows. And much of the mixing between channels is turbulent mixing.

CHAIR WALLIS: These velocities are really creeping flows.

MEMBER BANERJEE: Yes. So that would be a -- well, it should be looked at. I'm not saying the results are wrong.

MR. ANDREYCHEK: I understand. I

understand. I will offer that I did a calculation about five or six years ago where we looked at flooding the core from the side.

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: And we modeling the ability for the flow to go from assembly to -- channel to channel. And took into account the appropriate loss coefficients from a lateral standpoint. And we demonstrated reasonable results.

MEMBER BANERJEE: Yes, in fact I could probably do this by hand.

MR. ANDREYCHEK: I wouldn't argue that.

MEMBER BANERJEE: Yes, so --

MR. ANDREYCHEK: I wouldn't argue that. But, again, the RHR temperature did increase -- the temperature we were injecting into the reactor vessel went from the RWC temperature to 190 degrees Fahrenheit to simulate recirculation from the sump.

And we did look at two cases. And I think this answers your question specifically. The one case where we looked at the periphery being blocked. In the second case, we assumed everything except for the hot channel being blocked. And the hot channel not being blocked represented 99.4 percent of the core being blocked.

CHAIR WALLIS: How did the fibers know not to block the hot channel?

MR. ANDREYCHEK: We will get to that in just a minute. I don't have a slide specifically dealing with that but we can talk about that in just a moment please.

MR. DINGLER: They are smart fibers.

MR. ANDREYCHEK: Slide 48 just demonstrates a standard COBRA/TRAC model for the three loop pressurized water reactor. HA stands for the hot assembly structure.

CHAIR WALLIS: What does integrated mass flow rate mean?

MR. ANDREYCHEK: I beg your pardon.

CHAIR WALLIS: It says integrated mass flow rate?

MR. ANDREYCHEK: Yes. Bear with me and let me get to that slide.

CHAIR WALLIS: Oh, I'm sorry.

MR. ANDREYCHEK: Okay. Slide 49 shows the noting pattern of the blockage to the core for the two locations. And slide 50 talks about the containment pressure. We did drop it down low.

CHAIR WALLIS: Why did you just unblock underneath the hot channel. You could unblock -- that hole could be anywhere, couldn't it?

MR. ANDREYCHEK: That's true. We chose the hot channel for the purposes of if, again, we are 20 minutes into the transient. We have recovered the core. And the though process was if we restrict flow everywhere but the hot channel and we allow for the lateral distribution to flow out, the hot channel would be the one that would be tending to get the warmest later. It was an approximation.

MEMBER KRESS: It seems like the worst case maybe cell blockage everywhere.

MR. ANDREYCHEK: Right. Well, again, bear with me a little bit and we can discuss that in just a moment. I understand your comment, Dr. Kress.

Okay, we talk about flow through the blocked channel. And what the flow through the blocked channel means if this is the flow redistribution. And we are actually seeing what we would actually tend to see in the blocked channel over time. And fundamentally it peaks out, it bottoms out.

CHAIR WALLIS: What is being plotted here, this intake? What sorts of vertical access?

MR. ANDREYCHEK: It is the total mass flow that actually comes into the bottom of the channel.

CHAIR WALLIS: But it is a rate. So it is in pounds per hour or something?

MR. ANDREYCHEK: Right.

CHAIR WALLIS: What is that? Pounds per hour, I'm sorry. I apologize that we didn't have the units on there.

MEMBER BANERJEE: But the integrated mass flow rate.

MR. ANDREYCHEK: Right, that is correct.

MEMBER BANERJEE: What does that mean?

MR. ANDREYCHEK: That is the total flow through the bottom of the core. And what you see is at the time of the blockage, through the channels that are blocked, there is no more flow running through the bottom of the core. It basically says we've blocked that portion of the core.

CHAIR WALLIS: That's the green thing?

MR. ANDREYCHEK: The green and the black.

MEMBER BANERJEE: What is the black then?

MR. ANDREYCHEK: Again, if you look back at the model on slide 49 and take a look at the flow channels --

CHAIR WALLIS: That is 10, 11, and 12?

MR. ANDREYCHEK: Correct. You see that there is no more flow coming in.

CHAIR WALLIS: And where is 13 then? Oh,

13 is on the left. And on the right, why isn't 13 on the right? Because 13 is the only place that flow is coming in, isn't it?

MR. ANDREYCHEK: No, actually the channel that's coming -- it is channel 10, 11, and 12, if you look on the left-hand side for the 82 percent blocked case, what you are seeing is the flow -- if you want to call it deadlines at channels, 11, 12, and 1, which indicates that those channels are blocked. There is no more flow coming in through the bottom of the core.

MEMBER ABDEL-KHALIK: So the green, let's say, is channel 11, right?

MR. ANDREYCHEK: That's correct.

MEMBER BANERJEE: So just walk me through this green curve on slide 51, the left hand side.

MR. ANDREYCHEK: Okay.

MEMBER BANERJEE: What is happening on the left-hand side curve there, to the green?

MR. ANDREYCHEK: Up to 1,200 seconds, 20 minutes, the flow is bouncing around at up to about 300 or so seconds, we are getting a lot of flow coming in.

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: There is some flow perturbation, which bounces around a little bit. And then at 1,200 seconds, no more flow comes in.

CHAIR WALLIS: Why does it have those cliffs and then rise up again?

MEMBER BANERJEE: Well, that's before. You start your blockage at 1,200 seconds.

MR. ANDREYCHEK: That's correct.

MEMBER BANERJEE: And the green line after 1,200 seconds which goes horizontal means --

MR. ANDREYCHEK: That's correct. There is no more flow coming into the bottom. The blockage is --

CHAIR WALLIS: So integrated must be -- I don't understand.

MEMBER ABDEL-KHALIK: In pounds, rather than pounds per hour.

MR. ANDREYCHEK: Yes.

CHAIR WALLIS: Well, then there is a negative flow for part of the time?

MEMBER ABDEL-KHALIK: In some cases. It can't be rate.

CHAIR WALLIS: It must be --

MR. ANDREYCHEK: No, it is not rate.

CHAIR WALLIS: Okay. It is not rate. It is integrated mass flow. There is no rate there at all.

MEMBER BANERJEE: I'm just confused by the axis here.

MEMBER ABDEL-KHALIK: What are the units of the vertical axis? Maybe that would clarify. Sir?

MR. ANDREYCHEK: I'm writing a note.

CHAIR WALLIS: Pounds?

MR. ANDREYCHEK: I don't have an answer right now. Let me get back to you on that.

MEMBER BANERJEE: Because the integrated flow --

MR. ANDREYCHEK: It should be pounds.

MEMBER BANERJEE: -- could be going down only if the flow reverses.

CHAIR WALLIS: It must be going down part of the time?

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: That's correct. And you see the same or similar type of behavior on the figure on the left -- or, excuse me, on the right. Left lower right.

CHAIR WALLIS: And why does this mean everything is okay?

MEMBER BANERJEE: It doesn't. He is just showing us these figures. We don't know if it is okay yet.

MR. ANDREYCHEK: That's correct. We need to look at the flow temperatures.

CHAIR WALLIS: Well, we could probably spend a long time trying to figure this out. What are we supposed to conclude from these figures?

MR. ANDREYCHEK: Well, if we look at slide 53 --

CHAIR WALLIS: Well, I'm looking at slide 51. I'm not supposed to conclude anything from that except that there are some wiggles?

MR. ANDREYCHEK: Just some wiggles.

CHAIR WALLIS: I mean this is supposed to give me a message, isn't it?

MEMBER BANERJEE: You are going to clarify this for us then?

MR. ANDREYCHEK: I will clarify it for you.

CHAIR WALLIS: The whole idea is to give us a message that we can take away. And I can go home and tell my wife everything is fine in Washington, you know.

MR. ANDREYCHEK: Then let's look at slide 53.

MEMBER BANERJEE: All right. Let's look at 53.

MR. ANDREYCHEK: And slide 53 compares the boil off rate versus the --

CHAIR WALLIS: Boil off rate, it says integrated mass flow rate. And what are we looking at there? See I think there is a problem with what you mean by --

MR. ANDREYCHEK: I agree with you.

CHAIR WALLIS: So what is the message?

MR. ANDREYCHEK: The message that I would ask you to take back with you --

CHAIR WALLIS: Is that you guys are confused, right.

MEMBER ABDEL-KHALIK: No, they're not confused. It's just the --

MR. ANDREYCHEK: We need to make sure that the units are consistent on the axis.

CHAIR WALLIS: But this is supposed to convince us of something, isn't it?

MR. SCOTT: There is another message here which is that we don't even have the topical report that has this sort of activity in detail, right?

MR. ANDREYCHEK: That's correct.

MR. SCOTT: This is -- now the work you are presenting here is from the earlier topical or the later one that we don't have yet?

MR. ANDREYCHEK: This is the one from the one you don't have yet.

MR. SCOTT: Okay. So I guess what you are hearing from the Committee is that there is some lack of clarity in these graphs. And this is one that really is a work in progress. We owe you this at the next subcommittee meeting. This thing ain't ready for prime time yet I believe is my conclusion.

MEMBER BANERJEE: Well, as I guess as you have them here, the message is that 54 shows you that there is no problem with --

CHAIR WALLIS: Are you going to present this to the full Committee in July?

MEMBER BANERJEE: Do you want to?

CHAIR WALLIS: Are you going to get your act together and have a convincing story?

MR. SCOTT: I would suggest, Dr. Wallis, that tomorrow afternoon at the conclusion of all these discussions maybe we discuss --

CHAIR WALLIS: Tim comes back?

MR. SCOTT: -- what to present in July.

CHAIR WALLIS: Maybe Tim could come back tomorrow and tell us what he really meant to say today.

MEMBER BANERJEE: Now that you have whet

our appetites --

CHAIR WALLIS: Because these look very interesting. It looks very interesting. And I have not a clue what it means. I would be very happy for you to come back and tell us what it really meant.

MR. ANDREYCHEK: That is a fair comment.

MEMBER BANERJEE: We'll give you ten minutes.

MR. ANDREYCHEK: In ten minutes?

MEMBER KRESS: But be sure and check that cross flow correlation.

MR. ANDREYCHEK: Understood.

MEMBER KRESS: Because that's key.

MR. ANDREYCHEK: Understood.

CHAIR WALLIS: Yes.

MEMBER BANERJEE: I guess what you are arguing is even if a little bit of water gets through, it will find its own level because --

MEMBER KRESS: And it may convert into steam so it may still be an effective heat transfer.

MR. ANDREYCHEK: That's the point, yes.

CHAIR WALLIS: But the bottom line would seem to be slide 54 if we can believe it. That nothing really gets too hot.

MR. ANDREYCHEK: That is correct.

CHAIR WALLIS: And the blockage starts at the red line?

MR. ANDREYCHEK: That is correct.

CHAIR WALLIS: It doesn't do anything at all.

MR. ANDREYCHEK: That is correct. And part of the reason for that is the mislabeled --

CHAIR WALLIS: How bad does it have to be before it does have an effect?

MEMBER BANERJEE: I think it is a very simple calculation. If enough water gets in --

MR. ANDREYCHEK: That's right.

MEMBER BANERJEE: -- to the --

MEMBER KRESS: It makes the boil off rate --

CHAIR WALLIS: The boil off --

MR. ANDREYCHEK: That's right.

MEMBER BANERJEE: Yes, that's done at that point.

CHAIR WALLIS: Well maybe you could tell us how much the blockage needs to be in order for that to happen.

MEMBER BANERJEE: Yes. So you can work backwards exactly as Graham said.

MEMBER KRESS: The boil off calculation --

MR. DINGLER: Keep in mind that is sometime plant specific if you have bypass flows and stuff like that. So that --

MEMBER BANERJEE: I mean for the specific scenario where you can only answer the call from the bottom, if you get enough in so that you can have a stable --

MR. ANDREYCHEK: that's right.

MEMBER KRESS: A stable level.

CHAIR WALLIS: Yes. So while it is boiling off, it is leaving behind all the chemicals and debris which was in the water when it came into the core, right? So if you boil off for long enough, the core is full of all the stuff that didn't boil off.

MR. ANDREYCHEK: That's correct. You potentially will get some plate off.

CHAIR WALLIS: You're going to tell us that, too, presumably.

MR. ANDREYCHEK: That's correct.

MR. DINGLER: And as Mike says, that's the WCAP that is underway right now.

MEMBER BANERJEE: So you've got an early comment now.

MR. ANDREYCHEK: We got some today, yes.

(Laughter.)

MR. ANDREYCHEK: I appreciate it quite frankly. You know sometimes you don't see the forest for the trees. This is one forest I should have stayed out of.

CHAIR WALLIS: Are you going to come back to us and explain it? Are you going to have a try at that?

MR. ANDREYCHEK: I'm sorry, say it again?

CHAIR WALLIS: Are you going to come back tomorrow and explain it or not?

MR. ANDREYCHEK: I will have specifically correct -- yes, I will have the correct ones for tomorrow, yes.

CHAIR WALLIS: I think it would be good to have that on the record, too, that everything was sorted out.

MR. ANDREYCHEK: Not a problem.

CHAIR WALLIS: Okay.

MR. ANDREYCHEK: I regret --

CHAIR WALLIS: And everything is consistent with NRC findings? So the NRC findings were like this in summer of 2006?

MR. ANDREYCHEK: There was a blockage calculation that was done by NRC.

CHAIR WALLIS: And they concluded everything was okay?

MR. DINGLER: They concluded actually a slightly larger blockage and they still got acceptable core clad temperatures. So yes.

MEMBER BANERJEE: I suppose it depends on how the blockage occurs. I mean if you got blockage so that you have got this thin layer and you have got water seeping through --

MR. ANDREYCHEK: Well, that's pretty much the case, yes. If you have weeping flow, even if it is uniformly across the bottom, you will get that. And the point that I wanted to drive out and drive home was there was some testing that was done on representative fuel bottom nozzles and bottom grids where they took what would come through a sump screen, basically your bypass flow, with particulates in it. And ran this up into the bottom of the fuel grade.

And what was observed, both by industry and several NRC representatives, was that the flow did not -- was not blocked off. They still got flow through this fibrous particulate stuff because the flow was not sufficiently -- my guess is and in looking at it, it was not sufficiently fast enough, harsh enough to cause the fibrous material to mat.

And create the mat that would not allow flow to go through it. It was more of a -- I want to call it a fuzzy ball.

MEMBER BANERJEE: Was the experiment done of this study with heated rods or something?

MR. ANDREYCHEK: Not with heated rods. This was a cold assembly. It was done as an example of just -- at one -- someone wanted to see what it would look like. And so they jury-rigged up a loop that had a fuel assembly bottom nozzle and maybe two grids or so. And a bottom nozzle as well as the core support plate. And what they saw was that they got fiber collection there certainly that would be bypassed from the sump screen. But it did not form a map that chocked flow. They continued to get flow through there.

Furthermore, what they observed was upstream of this fibrous mat, they didn't get fiber concentrating into the fuel based upon photograph evidence that we have.

MEMBER BANERJEE: Is this documented somewhere?

MR. ANDREYCHEK: It's in the report that we are working on.

MEMBER BANERJEE: Oh, okay.

MEMBER KRESS: Basically this becomes an issue of a boiling pool rather than a turbulent convection heat transfer. As long as you can get water in the core and the water level is such that the steam cools the tank and the boil off rate is less than or equal to the input rate, then we're okay.

MR. ANDREYCHEK: That's correct, sir.

CHAIR WALLIS: So if I'm an operator --

MEMBER KRESS: That obviates the need for this cross flow plate.

MR. ANDREYCHEK: That's correct.

MEMBER KRESS: So you really don't need it.

MR. ANDREYCHEK: No.

CHAIR WALLIS: At a very low flow rate, you do.

MEMBER KRESS: Yes, a very low flow rate.

MEMBER BANERJEE: It just finds its own level.

MEMBER KRESS: Yes.

MR. ANDREYCHEK: That is correct.

MEMBER KRESS: Gravity will make it flow.

CHAIR WALLIS: And if I'm an operator and I begin to observe super heated steam, what do I do if I've got this? I know that I've got a LOCA. I know that I've got debris. And I'm somewhat concerned about possible blockage. And I begin to observe super heated steam coming off the top of my core, what do I do?

MR. ANDREYCHEK: Anyway I can to add more water.

CHAIR WALLIS: But how can you do that? Is there some way you can get water in the top of the core or something?

MR. ANDREYCHEK: There are a multiple of different ways depending on, again, that will be a very plant-specific evaluation. A lot of times those are covered in the severe accident guidelines.

CHAIR WALLIS: Well, do they go to hot leg injection and that kind of thing? Is that going to immediately ameliorate this situation?

MR. SCOTT: The cold leg or -- yes -- some of that is cold leg.

CHAIR WALLIS: Isn't that going to ameliorate the situation where water can come in from the hot leg and just come in from the top?

MR. ANDREYCHEK: There are something that are -- there are many things you can do. Some that are proceduralized. Some that are not.

CHAIR WALLIS: You should be able to get

60 pounds per minute into the core that way.

MEMBER BANERJEE: Well, wherever you put bypass flows, you are going to --

MR. ANDREYCHEK: That will hopefully be a conclusion.

CHAIR WALLIS: Well, that would be a very useful conclusion that no matter what happens, you are always going to be able to keep the pot full enough so that it doesn't boil dry.

MR. UNIKEWICZ: As Mr. Scott said, staff has not had a chance yet to look at --

CHAIR WALLIS: Okay.

MR. UNIKEWICZ: -- this WCAP. So some of these are --

CHAIR WALLIS: Well, that is very useful I mean to sort of know if you can convince us that no matter what happens with all this stuff, there is going to be a way that you can keep the core from drying out.

MR. UNIKEWICZ: Correct.

CHAIR WALLIS: Well, that would be very useful.

MR. ANDREYCHEK: And I don't disagree with you. I would suggest that, again, this calculation was done as a bounding type of a calculation. It's not meant to be representative of any situation. It is if it were to happen, could we get enough water in. And the answer was yes.

CHAIR WALLIS: Well, maybe it is time to finish this discussion. You have some work in progress here --

MR. ANDREYCHEK: Yes, I do.

CHAIR WALLIS: -- that we are going to see sometime like all the rest of what we saw today.

MR. ANDREYCHEK: Yes.

CHAIR WALLIS: And it looks as if you are making some progress. And some work needs to be done.

MEMBER BANERJEE: It would be nice to do an experiment. I always like experiments.

CHAIR WALLIS: With a core?

MR. ANDREYCHEK: I understand.

MEMBER BANERJEE: Well, not a real core. Just a few rods here and there.

CHAIR WALLIS: Okay. Can we move on?

MR. ANDREYCHEK: Thank you very much.

CHAIR WALLIS: Rather than taking a break, I'd like to move on and see if Steve, who has already had his time up here, can get us through pretty quickly.

MR. UNIKEWICZ: I suspect this can be as

quick as you desire.

CHAIR WALLIS: Okay. Do we have any copy of your slides?

MR. UNIKEWICZ: You should have them over on the edge further. It's not a long presentation nor is it meant to be because the purpose this presentation is to update you on where we are with respect to both in-core and ex-core downstream evaluations.

One change in the program, you may have noticed from the presentation in the past and that is Thomas Prayer has taken a position outside of the agency so I have been chosen to lead the charge, if you will, on the in-vessel evaluations also, certainly with a lot of support from additional staff, the same staff as before. Just that typically rather than Tommy, you'll probably hear myself talk about the in-vessel evaluations.

Where are we? Well -- and the purpose of this short presentation is to tell you where we are both from an in-vessel and an ex-vessel -- we'll start with the ex-vessel. We'll talk about some of the challenges and where we are going and how we are going forward.

Recognize that almost every licensee

currently has used 16406 Rev. 0, the initial issue of the PWR owners group WCAP on downstream effects. Revision 1 or draft revision 1 was the topical report that was submitted to staff for review.

So that being said, a lot of the current evaluations are based upon an earlier version that we are looking at. On February 16th, staff -- we issued 72 RAI with regard to this current WCAP. Where we are on it as of today is we've been having weekly phone calls. In fact, the latest phone call was this morning from 9:00 to 11:00.

And we're working through those 72 open issues. Now they did, the owners group did give us draft responses on May 3rd. And, again, on a week-to-week basis, we're going after them.

As of last week, there were currently six open RAI with regard to the in-vessel evaluations. Now 16406 does mention in-vessel evaluations, however it really describes them in a very broad brush standpoint. The later WCAP that we expect to see at the end of the month, 16793, if I've got my numbers right, will be that evaluation that does specifically address in-core.

So with regard to those six open items on in-vessel, they are more or less, I'll just say they're not wrong. They are just not specific enough. So there is a lot of -- there's detail to be added to make it very clear on how this evaluation portends to in-vessel.

With regard to the ex-vessel evaluations, there were approximately 17 open RAI, mostly focused on, as we mentioned earlier, the abrasive versus erosive wear calculations, how you model it. And the issue really becomes that the pump internals, it is not quite a classical two body wear model. And it is clearly not a three body model. So it is someplace in between.

So as we are working through that situation, that is where the bulk of the questions come from. They go back to the use of Brunell hardness. They go back to concentrations. They go back to pressure drop across from stage=to=stage to bearing loads and from the shaft. That's what the bulk of the current open items with regard to the pump evaluations are.

The open items with regard to valve evaluations, again, have a lot to do with not all classifications of valves were included. So there a few additional things that need to be added to this evaluation to make it complete.

The section on debris characterization is being completely rewritten. The owners group made somewhat of a presentation along those lines. We expect to see that hopefully in the next couple of weeks.

From an overall standpoint, this WCAP on our end should be wrapped up within the next three to four weeks, at least from a technical discussion. And I don't mean the writing in a safety evaluation. But it is delving through all the technical issues and working through the RAI.

There are a number of actions that aren't covered within this WCAP that need to be addressed by the licensees. Operator actions, where we talked about potentially opening up throttle valves, changing system line ups. That is not covered with the scope of this WCAP.

Stopping and starting of pumps, which would be an operator action, is not covered within this WCAP. Those things would have to be and are expected to be evaluated by licensee on their very plant-specific downstream evaluations.

Cyclone separators were not evaluated as part of this. Cyclone separators, there are a few plants that are struggling with -- the design of their cyclone separators and how they fit into their system. Some are the plugging of the cyclone separators. There are some decisions being made of whether or not they need to keep them or not.

And in a couple of cases, there is some testing being done at flow cert with regard to cyclone separator operation. Cyclone separators, again, are not covered s part of this WCAP. The expectation is that as licensees present their evaluations, that is covered.

So reactor fuel and, again, long-term cooling is covered in that additional WCAP.

There are some challenges. And part of the challenges is downstream pump valve heat exchanger evaluations are very plant specific and require large amounts of very plant specif information.

Jumping ahead to bullet 4, so some of the staff concern is if we have a reference book, if you will, the staff feels that a number of different people are going to be doing ths evaluation.

The struggle has been to put it to the point where a reasonably competent engineer in the field or from another organization would be able to use this documentation in an of itself to be able to go through this.

That's part of the struggle going through the RAI. And again, it is the WCAP is not wrong. Again, it is just not specific enough. We are adding a lot more detail to this evaluation so that other folks can use it.

Some vendors, as we mentioned, earlier, are using vendor testing and those plants that are those ones that, in effect, flunk the pump evaluations. If I decide that I'm getting too much internal wear on the pump such that my pump vibrates in excess and potentially disables my pump, those folks are going back and reevaluating. They are not using the very conservative inlet input assumptions of this WCAP. They are trying to do that.

We are looking at them on a case-by-case basis. The WCAP does not really address off-normal, if you will, situations nor is it intended to do that. It is intended to give a method to do calculations, a method to do evaluations within a very tight parameter box. If you are outside of that, then it is a little more difficult.

There are plant modifications planned, both planned and ongoing. There are people who have hard-faced internal components. There are licensees who are going through plant modifications whether they are adding orifice plates to allow opening of throttle valves. There are a couple of utilities that are hard-facing throttle valves. There are a couple that are doing a complete redesign of their HIPSI throttle valves.

So there are a number of different things going on. Since this is very plant-specific, those tend to be the ongoing challenges. As I mentioned, we are working with the owners group on a weekly basis. We have typically Tuesday morning phone calls with them. They tend to be very technical going through in excruciating detail the details of the WCAP.

The expectation is we get this safety evaluation and the revision one out sooner rather than later because from a practical standpoint, almost every licensee is going to have to at least do some sort of reevaluation of where they are.

CHAIR WALLIS: It is still very much work in progress.

MR. UNIKEWICZ: Well, I would say that it is a work in progress but we are converging upon a solution. And that convergence should be within the next -- realistically within the next couple of weeks.

CHAIR WALLIS: I guess I was hoping -- I've probably said it already today that you folks would come in saying certain things had been resolved so we could go away with a little more assurance that specific progress had been achieved. But that doesn't seem to be the case. A lot of things are still being worked on.

MR. UNIKEWICZ: I may have a little bit of issue with that in that many of the modifications that have been made to date have been down on the conservative end where at least on the pump and valve evaluations, where they failed, they failed miserably and quite early.

So while they did use Revision 0 and Rev. 0, we had some issues with it. When I look at the aggregate and you look at the end, realistically people probably aren't going to be making additional modifications because they did default on the conservative end even though the methods weren't 100 percent, if you will.

CHAIR WALLIS: Okay.

MR. UNIKEWICZ: The issue that we are -- at least from a component standpoint, ex-vessel, we should be done with it in the next month. So we are converging upon a solution. And again, these aren't -- they are not dramatically different from what we have seen.

CHAIR WALLIS: Can we move on to the in-vessel?

MR. UNIKEWICZ: Yes.

MR. SCOTT: Let me just add -- sort of sum up with what you had mentioned a second ago, Dr. Wallis. It is, in fact, the case with GSI 191 that we are still working on virtually every area of 191. And although we don't believe that, for example, ex-vessel downstream is going to be the long pull in the pin so to speak, we've got to dot the Is and cross the Ts and that has not been done yet in really any of these areas.

So we are fast approaching a deadline. And we are still pretty busy. So in September, October, this issue should be behind us hopefully. That the ex-vessel downstream will have in-vessel topical review results to talk to you about.

We are probably still going to be talking to you about chemical effects and where we are going with that. And we are not fully there yet. So it is still very much a work in progress with a lot of questions.

CHAIR WALLIS: Yes but some day soon you folks are going to have to come here and say we have resolved this. And this is why. Here is the evidence. And here is the logic and everything.

MEMBER BANERJEE: But does it have to be a complete resolution or do you resolve --

MR. SCOTT: Well, we've said all along there is the possibility here that we may say that we have reasonable assurance that Generic Safety Issue 191 has been resolved but there are specific technical questions still out there just like some of those things that Rob Tregoning talked about, the peer review panel items. Some of those may be part and parcel to resolution of 191. Or we may carry them in some other manner. Research may looking into them in a period that goes beyond when we currently planned to resolve this safety issue.

So the trick, of course, is to say well when we've gotten the uncertainties down low enough that we can have that --

CHAIR WALLIS: Well, what I'm thinking of though is that we've got all these things up in the air and today we haven't really dug in technically at any depth and do anything. And in order to be able to give some sort of ACRS assurance that everything is okay, eventually we are going to have to do that.

So it seems to me that we may have to have several subcommittee meetings where we dig into -

MEMBER BANERJEE: Specific items.

CHAIR WALLIS: -- specific things in some depth. That might take some time. So don't assume that when you have your critical path and all that it is going to be sort of a trivial tome to us with something substantial. And it is going to take some time.

MR. SCOTT: Well, I understand that. And if you look at the timelines we're talking about here, this topical report that Steve was addressing, will be hopefully final or the SER for it will be final in the fall so you could review that at that point.

CHAIR WALLIS: Well, you see everything else is there, too. We've got the chemical effect and everything else that is coming along in the fall. And it's a full-time effort in the fall trying to cope with all this stuff.

MR. SCOTT: Absolutely. And --

CHAIR WALLIS: The ACRS has other things to do so I'm not --

MR. SCOTT: But none more important than 191, right?

CHAIR WALLIS: Ahhh.

MR. SCOTT: Well, that is what everybody tells me.

MEMBER BANERJEE: I guess let's ask Susquehanna to take care of this.

MR. SCOTT: I understand that is might take -- and I guess it depends on how many of these particular subject areas you want to delve into. And we haven't even talked about coatings today.

CHAIR WALLIS: We will delve into anything that is important.

MR. SCOTT: Well --

CHAIR WALLIS: If you do a really good job, we won't have to delve into anything perhaps.

MR. SCOTT: I'm sure that is the way it will play out.

MEMBER BANERJEE: But what about plating. I mean you --

MR. SCOTT: About what?

MEMBER BANERJEE: -- talk about coatings but what about platings on these, you know, temperature gradient things.

CHAIR WALLIS: Yes, right.

MR. SCOTT: Are you talking about in-vessel? In the core?

MEMBER BANERJEE: Yes.

MR. SCOTT: The core?

MEMBER BANERJEE: Right primarily.

CHAIR WALLIS: And then the heat exchange.

MEMBER BANERJEE: The heat exchange may not be bad.

MR. UNIKEWICZ: Heat exchanger typically is not that critical a part. And the reason that it is not, there are a couple of reasons. One is that the type of materials used in the heat exchangers is more of -- following it tends to be a long-term phenomena with a half-inch, three-eighths inch tubing.

The --

CHAIR WALLIS: You are talking about wear?

MR. UNIKEWICZ: No.

MEMBER BANERJEE: No, we're talking about plate out.

CHAIR WALLIS: Plate out?

MR. UNIKEWICZ: The following of the heat exchangers. The second thing is shut down cooling heat exchangers in general, the way they are designed, they are designed for the maximum cooling load typically early -- maximum heat load. They are typically over-designed by 15 to 20 percent, depending on the vintage of the plant. Later plants were designed 10 to 15 percent.

When we are looking at the use of heat exchangers, shut down cooling heat exchangers, later on in the accident, we're talking at least better by half the design loads that most of these heat exchangers were initially sized for.

Now the calculations on heat exchanger evaluation, usually we'll make sure they have the appropriate falling factor for chemicals. And I am not as concerned about chemical effects, about shutdown cooling heat exchangers.

The plating out with regard to fuel should be covered by 16793, the in-vessel evaluations. So at least they should be addressed.

MEMBER BANERJEE: Maybe that would set our mind at rest. But we need to have it set at rest.

MR. UNIKEWICZ: Okay. The heat exchanger evaluation, at least the shutdown cooling heat exchanger piece is covered in 16406.

With regard to the vessel, the playing out of the vessel and I'll say boiler scale for lack of a better term right now, that is intended to be covered by 16793. Now understand that staff has not see this yet. The next couple of slides, which I may -- in your prerogative we'll either go through now -- were a number of issues that the staff had presented to the owners group back in February.

And really it was our request to ensure

that these issues are very specifically addressed within the WCAP.

MEMBER BANERJEE: I wonder if -- I mean some of these may not be resolved immediately. But things like cooling after blockage and things, potentially research could take a look at some of this inflect -- inflect is still alive and well and living in Pennsylvania. I'm not sure. Is it? Operational?

MEMBER KRESS: Who? Emergency cooling --

MEMBER BANERJEE: Yes.

MR. UNIKEWICZ: The core heat transfer test and no, that facility no longer exists.

MEMBER BANERJEE: It's gone?

MR. UNIKEWICZ: That is correct. It is gone.

CHAIR WALLIS: Well, the Flek Test doesn't exist but Hawkwright just built another one.

MEMBER BANERJEE: Hawkright has one in --

MR. ANDREYCHEK: You are talking about the Penn State test?

MEMBER BANERJEE: Right.

MR. ANDREYCHEK: That test facility is alive and well, yes.

CHAIR WALLIS: Well, we need to move on here. Are we going to be finished with in-vessel fairly soon here?

MR. UNIKEWICZ: We can be. And really the next seven slides really just explain those items we specifically addressed with the owners group while they were in the process of putting together 16793. Our expectation, when we review this and we get it next month, will be that they have addressed all of these issues as well as any others we have.

Now we did meet with the owners group yesterday afternoon. So while I say we haven't looked at the WCAP, there are issues that we are addressing currently with the owners group.

This over the next few months will be an ongoing, week-to-week process. There, the expectation is going to be if not weekly phone calls, biweekly phone calls going through all of the issues so that we can address our questions and ensure that things are being addressed in real time.

CHAIR WALLIS: I'm just looking at your slides. The things that you have on slides 12 through 15, 16, 17 are just the kind of questions I think that we have been having.

MR. UNIKEWICZ: Right. And these were the questions --

CHAIR WALLIS: They still seem to be

unanswered, is that right?

MR. UNIKEWICZ: Our expectation is those questions will be answered by 16793. They were, I'll call them preliminary RAIs because we hadn't received the WCAP. It was a presentation we had made to the owners group saying this is what we expect to see being addressed. This is what we expect to see being addressed once we receive the WCAP.

CHAIR WALLIS: Well, how are they addressing something like debris collected in restricted channels? Are they doing experiments or is it all analysis? Or what? How do they address something like that?

MR. UNIKEWICZ: We haven't seen the WCAP so I can't answer that question yet.

CHAIR WALLIS: You don't know how.

MEMBER BANERJEE: But I think you can guess that it is not with experiments.

MR. UNIKEWICZ: I can guess a lot of things. However, I would --

MEMBER BANERJEE: All right. We won't guess. But in case it is not by experiment --

MR. UNIKEWICZ: Mr. Andreychek, I'm sure, can answer that question. But I'm not going to be so presumptuous as to guess what is in the WCAP without looking at it. But these are our initial set of staff concerns that we expect these to be addressed when we see this over the next couple of weeks.

CHAIR WALLIS: There are three WCAPs here that are --

MR. UNIKEWICZ: There are three WCAPs that really effect downstream. One is the one Paul Klein had talked about earlier in the day, 16530.

CHAIR WALLIS: How many WCAPs are there overall that we are going to have to look at in the fall. There are three here and there are some more --

MR. UNIKEWICZ: these are the three. At least --

CHAIR WALLIS: Yes. But there are other ones on chemical effects and stuff.

MR. UNIKEWICZ: Well, 530 is the chemical effects one.

CHAIR WALLIS: So it is part of that one?

MR. UNIKEWICZ: Correct.

MR. SCOTT: There is another chemical effects topical report that the staff is not being asked to do an SE on. It is the one that was referred to by Paul Klein and others this morning regarding refinements of the 16530 methodology. So we're going to provide comments on that. And you all may want to take a look at it. But it is not going to be the subject of an SER.

MEMBER BANERJEE: Again, remind me what the methodology is.

MR. SCOTT: You remember that the owners group told you about, the chemical effects WCAP, which is -- they called it a model and you took some issue with that, remember.

MEMBER BANERJEE: Right, right.

MR. SCOTT: And then there were a couple of things in there -- a couple of subject areas and they went through it so fast. It was the second part of the presentation, that I think they kind of glossed over this. There is another report to follow that will contain those refinements that are trying to pull back some of the known conservatisms in the chemical effects modeling, okay.

That report is supposed to come in when? Mo, when?

MR. DINGLER: The end of the month.

MR. SCOTT: The end of this month, same as --

MEMBER BANERJEE: That is the passivation stuff?

MR. SCOTT: That is one of the examples of it, yes. And, again, they are not asking for an SE on that. So what will happen is is we will make comments on it. And licensees who choose to reference it will have to recognize what those comments were that we made. And incorporate that methodology at their risk, so to speak.

So now that makes four reports if you are interested in looking that one, which I assume you would be.

CHAIR WALLIS: Four reports and then several SERs from you?

MR. SCOTT: Three SERs. If you are interested in looking at our review guidance, additional review guidance that we are planning to develop this fall, that is another item. So there is a full plate.

MEMBER BANERJEE: I think we need a full-time consultant.

CHAIR WALLIS: Okay.

MR. UNIKEWICZ: I really didn't have anything more. If there are -- those nine bullets really were just our thoughts. That is where we are going with it. And just what we expect to review.

CHAIR WALLIS: I'd like to take a break until three o'clock. We are behind. We will try to catch up. But it looks as if we are going to be here at least beyond five o'clock. So we'll take a break now until three o'clock. And then we will hear from NEI.

(Whereupon, the foregoing matter went off the record at 2:48 p.m. and went back on the record at 3:03 p.m.)

CHAIRMAN WALLIS: We are looking forward to a presentation from NEI, and then we will move on to the real stuff from what the plants are doing. So let's go ahead.

MR. BUTLER: All right. Thank you. John Butler, NEI.

I just want to kick this off very quickly and turn it over to Salem for their discussion. But I wanted to start this off by pointing out that we have put together what we are calling four case studies to illustrate what the plant activities are to resolve GSI-191.

They are intended to give you a better sense of those activities. You have been listening this morning and early this afternoon of a number of the specific topic areas that are still underway, still have a high degree of uncertainty. Irrespective of this, the plants have a schedule they have to meet, and they are doing what they can with these uncertainties to meet that schedule.

So it is important to keep that in mind. Now the four case studies that we have picked -- There were a number of criteria that I put together to try to identify the plants for these case studies. I am looking for a range of resolution activities illustrated in these four cases, and I think we have accomplished that.

With these four cases, we have four of the five strainer designs being utilized. So you will get a little bit of insight into the range of strainer designs and the actions surrounding those strainer designs.

We also wanted to have, for lack of a better word, interesting cases. So I avoided picking plants that were low fiber, would basically -- are basically complete with their activities.

CHAIRMAN WALLIS: Do you have the one with all the aluminum in it?

MR. BUTLER: No. The final criteria and probably the most important criteria -- I'll preface that by saying you have to realize that there is a tremendous amount of activity underway at plants to meet the schedule that they have.

So my third criteria was finding four plants that would allow me to -- or would provide me the time necessary to give the presentation here. So I am very happy that I was able to find four plants to meet that third criteria, to give us the time to discuss what activities they have underway.

So with that, I will turn it over to Salem.

CHAIRMAN WALLIS: Now we are only going to hear Salem today.

MR. BUTLER: Yes. The three cases that will be discussed tomorrow are Fort Calhoun for OPPD, Wolf Creek, and Indian Point.

So with that, I will turn it over to Salem.

MR. RAJKOWSKI: Good afternoon. My name is Len Rajkowski. I am the design manager at Salem Station, and thus responsible for the ultimate implementation of the GSI-191 and the design basis of the station.

I have brought a team with me today to represent the different aspects, the vendors involved with this project, so that we can make sure you get the full enlightenment of that resource here today.

Starting off to my right is Kiran Mathur. Kiran is the lead responsible engineer for this project, the implementation. I would like him to go over the modifications specifically that we have done to date and yet to go.

To the right of him is Dr. Blumer. Dr. Blumer is with the strainer manufacturer, CCI. He will be talking about many of the design features, fabrication and testing.

To the right of him is Sargent and Lundy, our architectural engineering firm, performing most of the engineering analysis for this modification, and they are ready to discuss debris generation, debris transport and chemical effects analysis with Dr. Blumer's help, for sure.

With that, I will turn it over to Kiran.

MR. MATHUR: Thank you, Len. Before I start giving you what modifications we made, I don't know how much familiar you are with the old Salem plant. I will just give you a brief overview.

Salem is a four-loop Westinghouse plant. It is a dry large containers -- dry large containment. All the interpolate systems are located inside the bioshield area, and our containment sump is located in the outer annulus area.

We have two RHR pumps that take suction from the containment sump during the recirculation phase of the LOCA, and they provide cooling water to the reactor core -- to the reactor, to the high head and the low head pumps and also to the containment sump. The next slide, please.

The next slide just gives you a broad overview of how these systems are laid out. Okay. Next slide.

Just the containment layout. As I said, the ECCS sump is located along our annulus area. There are four entrances into the ECCS, and actually if during a postulated LOCA, all the degree that is generated inside the bioshield has a potential to flow through these openings and eventually could end up at the containment sump. Next slide, please.

Oh, and just to let you know, the initial pre-GSI-191 strainer layout, we had only 85 square feet of the strainer that was there. Next slide, please.

CHAIRMAN WALLIS: So this is different from some plants. You actually have some inner region where lots of the debris may get held up.

MR. MATHUR: That's right.

CHAIRMAN WALLIS: Are you taking credit

for that?

MR. MATHUR: We assumed the debris flows through the bioshield wall -- Yes.

VICE CHAIRMAN BANERJEE: Where are the bioshields?

MR. MATHUR: If you see those four circles. Those are the accumulators, and those walls or entrances are at that location.

VICE CHAIRMAN BANERJEE: They are pretty sizable openings?

MR. MATHUR: Yes. They are decent size openings. Okay. And if you see, our sump is located along the annulus area on the outside of the bioshield wall, along the wall of the containment.

The next two slides just give you an overview of the debris that we have that could be generated. It consists of the metallic reflective insulation, Nukon.

Predominantly, we have a lot of Nukon insulation. We have some calcium silicate, Kaowool insulation and this Min-K insulation, what we talked about today in the morning, and we have some qualified and unqualified coatings.

CHAIRMAN WALLIS: How much Cal-Sil do you have?

MR. MATHUR: We have -- What we did was we had around 400 lineal feet of calcium silicate that was identified within the zone of influence, and we have already replaced all the calcium silicate insulation.

CHAIRMAN WALLIS: So you've taken out all the Cal-Sil?

MR. MATHUR: That was within the zone of influence, yes.

CHAIRMAN WALLIS: And so this that's on the feedwater --

MR. MATHUR: And the blowdown piping.

CHAIRMAN WALLIS: -- is not likely to be affected, or is it?

MR. MATHUR: No, those two pipings had calcium silicate insulation, and we replaced it with the metallic reflective insulation.

VICE CHAIRMAN BANERJEE: What is the steam generator insulation?

MR. MATHUR: On Unit Number One, we have steam generator insulation is the Nukon kind insulation, and on Unit Two also we have Nukon insulation, but on Unit Number Two we are replacing those steam generators in the spring of 2008, and at that time the insulation will be replaced with metallic reflective insulation.

CHAIRMAN WALLIS: And the Min-K -- how much of that is there?

MR. MATHUR: We do not have much of Min-K insulation. This insulation is actually installed in some very hard to get, congested areas. So, really, where we have identified Min-K insulation, we have taken it out.

CHAIRMAN WALLIS: You have taken it out?

MR. MATHUR: Yes.

VICE CHAIRMAN BANERJEE: So this is before you made any marks?

MR. MATHUR: That's right. That's how it was before we made the marks. Okay?

CHAIRMAN WALLIS: So how big is the new strain or maybe you are getting to that?

MR. MATHUR: We'll talk about it. Okay.

This slide just gives you a perspective of our plan parameters we have. As I said, we have two RHR pumps. Each -- If one pump is operating, the maximum flow could be 5110 gpm for the Unit One and 4890 for the Unit Two, and if the two pumps are operating, we have 9,000 gpm flow.

The next, the columns show you the NPSH required, and then we talk about the flood height.

CHAIRMAN WALLIS: It's a fairly high NPSH, I would say.

MR. MATHUR: Right. Then we have the flood height, and our formulate is sodium hydroxide.

VICE CHAIRMAN BANERJEE: What do you mean by the flood height?

MR. MATHUR: Oh, what we determined was, if you have a LOCA, what is the minimum amount of water that could go into the containment, because what we wanted to make sure is our new strainers that we are installing are completely submerged underwater.

So we determined the minimum flood height.

VICE CHAIRMAN BANERJEE: This is the height above the sump bottom?

MR. MATHUR: Yes. Our containment is at the elevation 78. Okay? So we will -- 2 foot, 10 inches. This would be --

CHAIRMAN WALLIS: So 80 feet of water.

MR. MATHUR: That's right. I'm sorry. That's what it meant.

CHAIRMAN WALLIS: Okay.

MR. MATHUR: Okay. The next slide shows the existing sump that we have. Oh, I'm sorry.

CHAIRMAN WALLIS: Are you thinking of changing the buffer material?

MR. MATHUR: No, we do not. No.

The next slide talks about the plant modifications.

VICE CHAIRMAN BANERJEE: You do not, but why not?

MR. MATHUR: We did not find any -- Based on our chemical testing we have done, we did not find any necessity of doing it at all. Okay?

The next slide talks about all the plant modifications we have made. As you see, initially we had about 85 square feet of strainer -- On Unit Number one. We have installed 4,854 square feet of strainers. Okay? We replaced our existing --

VICE CHAIRMAN BANERJEE: This is open area. In other words, they are stacked strainers. You are counting all the area.

MR. MATHUR: That's right. This is the pockets. These are the pocket areas. This is strainer area. That's exactly right. Okay? And we removed our existing enclosed -- sump enclosure. We installed a new sump enclosure and, as we just said, we have around 23 strainer modules. There are 140 pockets each, and we have one strainer module that has 210 pockets, and all these strainer modules are lying next to each other, and eventually they connect to the containment sump.

Other thing we did was we installed new level switches. The new level switches were installed, because the existing -- the original level switches have a higher uncertainty. So these level switches provide a very tight uncertainty. It is plus or minus half an inch.

So we can get a very good indication of what our containment flood level is. And the new sump strainers that we have installed have perforated holes of 1/12th of an inch. Previously, we had 1/8th of an inch openings.

MEMBER ABDEL-KHALIK: These level switches are just for the operators information or --

MR. MATHUR: These are -- No, these are -- They tell the operator that at -- When the containment flood level goes to 62 percent, the switchover can happen to the recirculation phase.

So, basically, it gives the operators indication that they can turn over to the recirculation phase. Okay?

CHAIRMAN WALLIS: So this is a tremendous improvement.

MR. MATHUR: Absolutely is.

CHAIRMAN WALLIS: Orders of magnitude.

MR. MATHUR: Yes.

VICE CHAIRMAN BANERJEE: And this perforated plate --

MR. MATHUR: We installed a trash rack in front of our strainers. I'll show you in a picture. Yes, we have a picture of that one, and we installed -- even installed a perforated plate behind this trash rack to act as a pre-strainer.

VICE CHAIRMAN BANERJEE: What were the size of the old one?

MR. MATHUR: Same size as our strainers, 1/12th of an inch.

CHAIRMAN WALLIS: Why don't you work in metric system?

VICE CHAIRMAN BANERJEE: Now this perforated trash rack -- perforated plates -- can't block up, can it?

MR. MATHUR: It does not matter. As you see -- Yes, that's right. It should not be a problem at all. Then as you --

CHAIRMAN WALLIS: You are taking credit for something with this trash rack perf plate?

MR. MATHUR: We'll talk about it a little bit later in the presentation about it. Okay?

Again, as is aid, we replaced around 400 linear feet of calcium silicate insulation and replaced the Min-K insulation with reflective metallic insulation. The only thing is in certain areas where it was -- because of the accessibility concerns, we had to install some Nukon insulation instead of it, and that amount of Nukon insulation was taken into consideration when we did our debris generation calculation.

VICE CHAIRMAN BANERJEE: Where was this accessibility?

MR. MATHUR: The piping comes from the reactor. It goes -- From the nozzle it goes through a bioshield -- into the bioshield wall. So inside the wall it was very difficult for us to put in the metallic reflective insulation, because of very tight clearances. So that's why we put in this Nukon insulation.

VICE CHAIRMAN BANERJEE: Inside the bioshield?

MR. MATHUR: That's inside the wall.

CHAIRMAN WALLIS: How much did you have to consider radiation to the personnel who were putting this in?

MR. MATHUR: No, it was -- The radiation was not that much at all, and also inside the bioshield also, when the piping comes out of the reactor nozzle, it is sitting in a place called the sign box. So periodically we inspect the nozzles. So in the last outage we removed that sign box. So at that time, we replaced the insulation. So there was no additional -- those workers, what you are talking about, impacted by this modification.

CHAIRMAN WALLIS: What is this big black thing here?

MR. MATHUR: This is the reactor wall. What I'm positive is it's our refueling --

CHAIRMAN WALLIS: So you have holes in that for the things that go through all that black?

MR. MATHUR: Yes, that's right.

CHAIRMAN WALLIS: And you have to somehow change the insulation in those?

MR. MATHUR: That's right, yes, inside those walls. It was not that much of a difficulty.

CHAIRMAN WALLIS: So if you have a LOCA inside, it would be protected then from blowing insulation off the steam generator, if you have a LOCA inside that wall.

MR. MATHUR: Yes.

CHAIRMAN WALLIS: That's a very substantial wall there.

MR. MATHUR: Yes.

VICE CHAIRMAN BANERJEE: How high is that wall? As high as the reactor?

MR. MATHUR: Yes. It goes above the reactor.

VICE CHAIRMAN BANERJEE: Above the reactor?

MR. MATHUR: Yes. Next slide, please.

This is the Unit Number Two modifications. They are very similar to what we just talked about Unit Number One. The only main difference is that we have one less module installed on Unit Number One. This is again because of the access ability concerns.

We had an interference at one location. so we had to put a transition connection between the two strainer modules instead of a strainer there. Other than that, all the modifications on Unit Number One is similar to Unit Number Two, and both these installations have been completed now. Okay.

The next slide shows the old sump strainer layout. As you see, it was just a small box, and that's all. It had the strainer around it, and the water would just go through it.

The next slide --

VICE CHAIRMAN BANERJEE: What are we seeing, actually, here?

MR. MATHUR: This is the -- strainer box -- This is the old sump strainer box. Okay?

CHAIRMAN WALLIS: We have the treads on the ladder. So I guess we have some idea.

MR. MATHUR: It was -- If I'm not mistaken, it was like 8 feet by 3 feet. The total square footage was 85 square feet.

VICE CHAIRMAN BANERJEE: So how high was it?

MR. MATHUR: Around 3 1/2 feet, if I am not mistaken, three feet. Yes, three feet.

VICE CHAIRMAN BANERJEE: Okay. And what is those vertical lines there?

MR. MATHUR: Those are the existing -- Those are the level instruments that we have, the level indication instruments.

VICE CHAIRMAN BANERJEE: Within this box?

MR. MATHUR: Oh, these ones? These are what we call the trash recs, so that you start the big debris from going in. In fact, that we had the screen mesh.

CHAIRMAN WALLIS: Oh, the strainer is even smaller. It's inside there.

MR. MATHUR: Yes.

CHAIRMAN WALLIS: It's gone now anyway. So we don't need to worry about that.

MR. MATHUR: Okay. The next slide shows--

CHAIRMAN WALLIS: It's in a museum somewhere?

MR. MATHUR: Yes. The next slide our Unit Number One enclosure, the sump enclosure.

CHAIRMAN WALLIS: This is the new one?

MR. MATHUR: Yes, this is the new sump enclosure that we have installed, and it is very similar on Unit Number Two also, and all the strainers connect to this one, and all the pumps take suction from underneath.

CHAIRMAN WALLIS: This is all stainless steel?

MR. MATHUR: That's exactly right.

VICE CHAIRMAN BANERJEE: So what is this that we are seeing there, the stainless steel box there. What is it?

MR. MATHUR: This is the enclosure that is sitting on top of our sump pit, and all the strainers connect to this enclosure.

VICE CHAIRMAN BANERJEE: So where does the water --

MR. MATHUR: We'll see the next slide. Okay, now if you see the next slide, the next slide shows the strainers that we have installed. Okay? And all these are interconnected, and they dump the water into --

CHAIRMAN WALLIS: Now let's see. The strainer -- there's a layer at the bottom which is different. Those are --

MR. MATHUR: Those are the trash racks we just talked about.

CHAIRMAN WALLIS: These at the bottom? Oh, those are trash racks?

MR. MATHUR: Yes.

CHAIRMAN WALLIS: So the pigeonholes go down behind the trash racks, do they?

MR. MATHUR: Yes, they do.

CHAIRMAN WALLIS: They are just hidden at the bottom?

MR. MATHUR: Yes, they do. It goes to the bottom.

CHAIRMAN WALLIS: So in order for the top level here to be activated, there must be an enormous amount of water in this area.

MR. MATHUR: Yes. It has to go to 2 feet, 10 inches, and these strainers -- the height is 2 feet, 7 inches.

VICE CHAIRMAN BANERJEE: Oh, so this height is 2 feet, 7 inches?

MR. MATHUR: the height of the strainer right now is 2 feet, 7 inches.

CHAIRMAN WALLIS: A big containment. The diameter is 200 feet or something?

MR. MATHUR: I don't remember.

CHAIRMAN WALLIS: It's big.

MR. MATHUR: Yes, it is.

CHAIRMAN WALLIS: It's large.

MR. MATHUR: Yes. I think, if I am not mistaken, the when -- The refueling water storage tank dumps in around 400,000 gallons of water.

MEMBER ABDEL-KHALIK: So where on this picture is the 2 foot, 7 inch elevation from the floor?

MR. MATHUR: That is the top of the strainer module.

MEMBER ABDEL-KHALIK: The top?

MR. MATHUR: Yes.

MEMBER ABDEL-KHALIK: Okay. Thank you.

VICE CHAIRMAN BANERJEE: Those pigeonholes?

MR. MATHUR: Yes, the top of the

pigeonholes, and those are the strainer pockets we talked about.

CHAIRMAN WALLIS: They are all encoded by ZIP Code, in other words.

MEMBER KRESS: Only a certain degree goes in this.

VICE CHAIRMAN BANERJEE: I still can't get what is the function of that big stainless steel --

CHAIRMAN WALLIS: Collection.

MR. MATHUR: No. All the water goes into the box -- or pit.

VICE CHAIRMAN BANERJEE: Underneath that.

MR. MATHUR: Yes, that's right, and it has the level indication also.

CHAIRMAN WALLIS: Is that where the old strainer used to be there?

MR. MATHUR: That is exactly right.

CHAIRMAN WALLIS: Same staircase, but new strainer.

MR. MATHUR: We had to even modify the staircase also to accommodate the new layout. We had to do a lot of modifications, because even these new strainers that we had, we had to do a lot of modifications, because we had some cable tray --

CHAIRMAN WALLIS: Well, you were lucky in a way. You have a lot of open space to put this strainer.

MR. MATHUR: No, but you have to realize, when we did this modification, we had to do a lot of pre-work, because those areas were all covered with the cable tray supports. So we had to cut off part of the cable tray supports and put these bridges. If you see those, you see those bridges around? So those were the cable tray supports that went all the way to the floor.

CHAIRMAN WALLIS: Okay. But at least you did have some space. It's just that you had the poles in there.

MR. MATHUR: Okay. Now if you see this slide on the screen, it shows you --

CHAIRMAN WALLIS: Which one is that?

MR. MATHUR: I'm jumping ahead to Slide 39.

VICE CHAIRMAN BANERJEE: That is much clearer.

MR. MATHUR: That's right.

CHAIRMAN WALLIS: Well, 39 is a long way ahead.

MR. MATHUR: Yes. Dr. Blumer is going to talk more about it.

VICE CHAIRMAN BANERJEE: Yes, but it shows you the layout.

CHAIRMAN WALLIS: I got that impression already, I think. Are there dimensions on it.

VICE CHAIRMAN BANERJEE: One has the suction box on the left, and the other on the right.

MR. MATHUR: That's right. They are opposite plans. If you see, we tried to put in as much of strainers as possible based on the real estate, and if you see at the end, we have this lift tank. That's where we could not go any further beyond.

VICE CHAIRMAN BANERJEE: So you just put as much in the way of strainers as the space would accommodate?

MR. MATHUR: Yes. Almost, yes.

CHAIRMAN WALLIS: So the river of stuff comes in through this -- around this yellow whatever it is here. It comes in around this door. There's a door. There's a space.

MR. MATHUR: Yes. All the doors, yes.

VICE CHAIRMAN BANERJEE: So the green stuff there is the bioshield. Right?

MR. MATHUR: That's right. That's the bioshield wall.

VICE CHAIRMAN BANERJEE: The yellow circle is the opening -- that area?

MR. MATHUR: Actually, that is an accumulator there, and that's where the opening is. Yes.

MR. RAJKOWSKI: Yes. The openings would be on both sides of each accumulator. So there is actually -- You are looking at eight openings.

MR. MATHUR: Right.

VICE CHAIRMAN BANERJEE: But this is one of those eight openings.

MR. MATHUR: That's exactly right.

DR. BLUMER: The only thing that is not shown is the trash rack on both sides of this.

CHAIRMAN WALLIS: Right.

VICE CHAIRMAN BANERJEE: Which is shown in that other picture.

MR. MATHUR: Other picture, yes.

CHAIRMAN WALLIS: Okay. So we are going to go back to 19 or wherever we were? Sixteen? Well, it's all the same.

MR. MATHUR: Yes. The two pictures shown one for Unit Number One and one for Unit Number Two, actually, which are very similar to each other.

CHAIRMAN WALLIS: And you are keeping the floor very clean.

MR. MATHUR: Oh, we keep it very spick and span, actually. It's very clean. There is no question about that, and we have a very tight -- We'll talk at the end. We have a very tight control on anything that goes inside the containment. The next slide.

I think we talked a lot a little while back on the downstream effects. I don't know how much you want to talk about it. But as we said, we have the strainer openings that are 1/12th of an inch, and still some debris can pass through it.

So what we did was we went in and looked at all the components on the downstream of the sump, and we identified around 151 components for Unit Number One and 156 for Unit Number Two. We even did a bypass testing at the CCI facility, which Dr. Blumer will talk later on.

The downstream components consisted of pumps, heat exchangers, valves, orifices, everything, and our analysis showed that the downstream clearances are acceptable. We did not see any problems with them at all.

As far as the in-core thing is concerned, Westinghouse did a design specific evaluation for us at the time, and we determined that we do not have any core blockage problems; and now based on the presentation we just saw, we just saw that even if you had 99 percent core blockage, there is no problem.

VICE CHAIRMAN BANERJEE: And you had no blockage at all or you had --

MR. MATHUR: No, no. We calculated around 28 percent blockage. What we did was we -- When the bypass testing was done, we did a very specific analysis. We measured the fiber that got bypassed, and then evaluated as to how it would fit in on the grid, and we found out that a maximum of 28 percent of blockage.

CHAIRMAN WALLIS: So how many pick-up loads of debris would you release in a LOCA?

MR. MATHUR: We'll talk about it.

CHAIRMAN WALLIS: You're going to tell us?

MR. MATHUR: Yes. We have a lot of information on that.

MEMBER ABDEL-KHALIK: Now when you say 90 percent of blockage can be accommodated --

MR. MATHUR: That's what we just talked about.

MEMBER ABDEL-KHALIK: What does that mean, quantitatively?

MR. MATHUR: No. What I meant -- What we meant to say was what was discussed, the WCAP is saying that, even if your core, at the bottom of the core, is 90 percent blocked, still you could cool down the -- You will not have any core cooling problems.

MEMBER ABDEL-KHALIK: You would meet the acceptance criteria?

MR. MATHUR: That's right.

MEMBER ABDEL-KHALIK: In terms of peak clad temperature.

MR. MATHUR: That's exactly right.

MEMBER ABDEL-KHALIK: During a LOCA.

MR. MATHUR: Yes.

CHAIRMAN WALLIS: This is a big room that these things are in. I would think the velocities in there would be pretty small except near the openings.

MR. MATHUR: Actually, they are rather high. Again, we will talk about it.

CHAIRMAN WALLIS: Okay, you will talk about that?

MR. MATHUR: Yes. We have quite high velocities.

CHAIRMAN WALLIS: Okay.

MR. MATHUR: And also the next slide, we looked at the wear components, and we did not have any problems with them also.

CHAIRMAN WALLIS: That means that the wear was --

MR. MATHUR: Acceptable.

CHAIRMAN WALLIS: So less than a mil or something, that sort of thing?

MR. MATHUR: I will say it was acceptable. I do not have the calculation in front of me right now. So I can't answer -- quantify the number, but it was evaluated in accordance with the Rev. 0 of the WCAP we talked about.

CHAIRMAN WALLIS: Okay.

MR. MATHUR: Now I will turn over to Bob Peterson. He will talk about what we were just talking about, the W generation and transport evaluations that we did, and he will talk a little bit about the chemical analysis also.

MR. PETERSON: Thank you, Kiran. As introduced, I am Bob Peterson from Sargent and Lundy. We did a number of the support calculations, and we will go into the details of three of them that are of prime interest here.

The first ones are the debris generation, and it is tied directly to the debris transport. The goal of these calculations is to determine a maximum debris load to forward to the test engineer to demonstrate acceptability of the screen.

This process is really somewhat of an iterative process, meaning we started off quite a long time ago with a preliminary load, and as you can see, we put in a very, very large screen. Then through evolutions in the industry, better information, better tests, we have refined the load, but basically we have followed the NEI-0407 document as accepted and as -- well, as discussed in the NRC SER with two notable exceptions.

One is we have incorporated the smaller ZOI of 5D for the qualified coatings. I believe a number of utilities have done this. It was very important for Salem in that, while they have a very small unqualified coatings relative to other utilities, inside the zone of influence, let's say, someone coated of lot of component. So this reduction was pretty significant for us.

CHAIRMAN WALLIS: You don't have a scale on here, but the zone of influence can hardly be spherical with all these walls around.

MR. PETERSON: It's a spherical zone, and it is truncated when you hit a solid -- you know, when you hit the wall.

CHAIRMAN WALLIS: It's a big strange, because don't you think it might bounce off the wall and move off to some other area, but you just cut it off when it hits the wall?

MR. PETERSON: You cover -- Yes. But you are covering big, big chunks of this containment. It's really what -- It is limiting you.

CHAIRMAN WALLIS: If we look at, say, break S6 here, that's a double-ended guillotine break. Is that what that is?

MR. PETERSON: Yes.

CHAIRMAN WALLIS: How big is that zone of influence? Could you just sort of indicate for me?

MR. PETERSON: Depends on the target.

CHAIRMAN WALLIS: Well, does it reach number 13-SG?

MR. PETERSON; Yes.

CHAIRMAN WALLIS: So it takes in pretty well that whole side of the containment?

MR. PETERSON: Once again, it depends on the target, not a 5D coating, but on the insulation.

CHAIRMAN WALLIS: On what the stuff is?

MR. PETERSON: Right.

CHAIRMAN WALLIS: But if it's Nukon, it's pretty big.

MR. PETERSON: Right.

VICE CHAIRMAN BANERJEE: When you say 5 diameters, 5 diameters is of the pipe?

CHAIRMAN WALLIS: For Nukon, it's more than that.

MR. PETERSON: Yes. The slide that is up there still, the SER had a 17D. We are using the AT, which was subsequent.

CHAIRMAN WALLIS: It's on three feet?

VICE CHAIRMAN BANERJEE: So you say that the justification for this is contained in WCAP not yet available?

MR. PETERSON: Yes. There's some subsequent testing that was sponsored.

MR. DINGLER: This is Mo Dingler. Tomorrow at Wolf Creek you will see the actual blow of that Nukon. I have that in my slides.

VICE CHAIRMAN BANERJEE: So you have data?

MR. DINGLER: Yes. So if you want to postpone that until tomorrow --

CHAIRMAN WALLIS: So there is something else that we could evaluate, if we wanted to.

MR. PETERSON: Okay. As shown on this slide, we looked at many break locations on the primary loop, and one at the base of the pressurizer.

VICE CHAIRMAN BANERJEE: Let me ask you something. Suppose you had used 10D and 17D. How much more debris would you have got?

MR. PETERSON: The 10D to 5D was approximately a 50 percent reduction on the coating load.

VICE CHAIRMAN BANERJEE: Okay. And the 8D versus 17D?

MR. PETERSON: That was because of the actual locations -- Well, okay. The amount that was generated went down by about 50 percent. What happens, though, as you get to smaller and smaller zones of influence, the particles, the size distribution, becomes skewed more and more. So you get smaller and smaller particles.

We will get into where that ends up helping you or what happened there. So as I have very, very large zones of influence, we use a 4 to 3 size categorization of intact, large, small and fines. The percentage of fines continues to go up as those zones go smaller.

VICE CHAIRMAN BANERJEE: But the amount?

MR. PETERSON The amount also -- well, goes down as I reduce --

CHAIRMAN WALLIS: The percentage goes up.

MR. PETERSON: The percentage of the lower end categories goes up. So it's the net, but there is also an erosion term which feeds into why we put the trash rack in.

VICE CHAIRMAN BANERJEE: If this is a spherical zone of influence, then that really means that you have a volumetric chain that goes almost a volume of eight.

MR. PETERSON: That would be true if you had a containment that was solid of Nukon, but you have specific targets.

VICE CHAIRMAN BANERJEE: Right. Right. So it hits the steam generator there, number 11?

MR. PETERSON: For a break in one loop?

VICE CHAIRMAN BANERJEE: At 6, yes.

MR. PETERSON: It hits 11.

CHAIRMAN WALLIS: Well, the big one hits 13, I think.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: But now S1 will not hit 13. Right?

MR. PETERSON: Correct.

VICE CHAIRMAN BANERJEE: Whereas, if you had that old thing, it would have hit 13.

MR. PETERSON: And as Mo said, he will

show you those, I guess, or discuss those tomorrow, but the results of that testing at these 8D indicated no damage, you know, slight bending of the jacketing, that type of thing. So what we have done is --

VICE CHAIRMAN BANERJEE: Steam generators in any case are going to be all RMI, aren't they?

MR. MATHUR: That's on Unit Number Two only. Unit Number One insulation was already replaced, and at that time everybody like Nukon. So we put in Nukon at that time.

MR. PETERSON: It's one of the very ironic things in the industry, that the people that have already replaced their generators predominantly a new plant, switched from RMI to Nukon because of heat loss issues and fit-up issues in the containment, and now the solution from GSI would have been to put RMI in.

These break locations, as I have discussed, though, are based on trying to maximize the problematic debris, ease of transportation, and then to provide an appropriate mix of the problematic debris. So we look at a number of them, and we have worked through these various break locations. As you --

VICE CHAIRMAN BANERJEE: All this Nukon on Unit One doesn't lead to a different design of your strainer system or anything?

MR. PETERSON: The testing is different, and we will show you that. Predominantly, that is the lead unit, meaning if you can demonstrate that one works, you are probably pretty far along on the Unit Two, and we will show you those differences.

Okay. Next slide. I think this came up earlier today. There was some discussion about this latent debris. That was the terminology we are using. This is the background dirt dust.

We used masolin cloths and wiped down areas of containment. So you measured out so many square feet of a horizontal, vertical pipe, different types of areas of the containment, and wipe these areas down. Then we used a statistical analysis to combine those, and then took that loading rate, so many grams per square foot, and then multiplied by how many square feet of that type of area in containment.

We had already started the analysis, and early on a number was, oh, we will say floated around the industry of about 200 pounds as a number. It was never endorsed. It was just a number sort of floated around as a starting place.

These walk-downs substantiated substantial margins. As shown in the photos from Puron earlier, the containment is pretty clean. So it was just a confirmatory analysis.

Also during the walkdowns, we validated what -- we'll use the terminology of foreign materials. These are the placards, the labels, and we have included those in the analysis. They become basically sacrificial area, area on the screen that we are not crediting as far as something of a filter-out fiber or particulates. Next slide.

CHAIRMAN WALLIS: You've only got one cubic foot of latent particulate. That is a pretty clean containment.

MR. PETERSON: Well, that is based on the 200 pounds, 15 percent of 200 pounds. Yes. So this starts answering questions of kind of how many truckloads. Regrettably, they are in cubic feet, and I don't know the payload.

CHAIRMAN WALLIS: Well, I was going to say it's about 400 cubic foot. Depends how much you pile it in, but something like that.

MR. PETERSON: Okay.

CHAIRMAN WALLIS: So you've got one truckload of Nukon. Not too bad.

MR. PETERSON: Yes. And like I said, the qualified coatings is down. You know, the 12.6 cubic feet is the reduced value, as is the Nukon.

VICE CHAIRMAN BANERJEE: How much is the truckload?

CHAIRMAN WALLIS: Four or five hundred cubic feet. That's a good full-size truck reasonably loaded.

MR. PETERSON: I know, when we do these tests, they are scaled values and scaled factors of like 50, and we have quite a few garbage bags and cans of debris to throw out.

CHAIRMAN WALLIS: Now wait a minute. No, I'm sorry. I was comparing -- I was dividing it by -- I got five truckloads. It's about 80 to 100 cubic feet. I'm sorry, I was multiplying by five. Okay.

MR. MATHUR: I just want to make one clarification. When I was talking, I said that we had replaced all our known Min-K insulation. The only thing I did not tell you was -- and on Unit Number One you see apparent 5.3 cubic feet of Min-K insulation that we are putting in our testing.

The reason was, as I said, on Unit Number One we did not remove our sandbox. So it would have been very expensive for us to replace that insulation. So we are going to do it in the next outage of Unit Number One, which will be toward the fall of next year.

So in the meantime we have added that one into our debris generation calculation here, and for Unit Number Two you see a 24 cubic feet number. The reason is our drawings show this to be a metallic reflective insulation, but some of our people who do a lot of walkdown, they think there is some Min-K insulation. So just to be on the conservative side, we have put that in our debris generation calculation.

VICE CHAIRMAN BANERJEE: So latent fiber looks like 12 1/2 cubic feet; whereas, latent particulates is one. So you have latent fiber which is roughly 12 times as much as --

MR. PETERSON: The ratio -- It's 85 percent fiber to 15 percent particulates.

CHAIRMAN WALLIS: This is from clothing. Is that what it comes from?

MR. PETERSON: Well, the numbers we use, there was several stations that provided samples, I believe, to Los Alamos, and they did a screening. That was the average, and given the margin we have put into our total relative to what we measured.

CHAIRMAN WALLIS: Was debris from the fiberglass and stuff like that cleaned up?

MR. PETERSON: Yes. We didn't really

characterize it. These are weight samples, and we used the characterization that was out there.

You know, the one thing that really is interesting on that is, of course, people had normal housekeeping, but no awareness of GSI 191 for all years of operation. Well, now they do. They are going to be cognizant of that, and this is -- We went in there and did these walkdowns.

You know, it was what was out there after all these years, and it really was not much at a plant like Salem, and we have sufficient margin, we feel, using this 200 pounds.

Okay. So after the values are generated, the next portion is the debris transport. We are in agreement with the NEI 04-07 document and the associated SER guidance.

We made limited use of CFD, and we will go into what that is. I see color photos open. We used FLUENT 6.1.22. And if you look at this photo, what you will see is the inside of the containment -- next slide -- looks like it's missing.

Well, it is in the CFD analysis. When we are at this minimum flood level of 2 feet, 10 inches, the inside -- this inside annular area is an elevated portion of the containment. So the openings we were discussing down by the accumulators, you actually have to go downstairs.

So early when you go into recirc, there really is no water except the sheeting action inside the annulus. So even though we have a very large containment, the water is all concentrated out in that outside annulus, and we have relatively high velocities.

VICE CHAIRMAN BANERJEE: Why is the lower velocity around the upper left?

MR. PETERSON: The door -- Yes, in the 10 o'clock position. That door is -- We did not modify that door, and there is an extremely strong potential that door will block.

VICE CHAIRMAN BANERJEE: You blocked it in your calculations?

MR. PETERSON: We blocked it analytically, because we believe that would be the first door, and it would block. For this simulation, all we were really trying to do was, by maximizing the flow-out of the other three doors, you will see the one adjacent to that at like four o'clock has some relatively low velocity region. That's all we are really trying to credit here, is some minor settling in that area, and it really was not that successful, because of the relatively high velocities.

VICE CHAIRMAN BANERJEE: But you have some velocities which look like zero. Right?

MR. PETERSON: Yes. There is a dead spot between the two doorways, between the one at two o'clock and four o'clock there or whatever. There is a dead spot, and that would be expected, because the screen -- It's which unit we are showing. The screen is in the upper -- in the lefthand side.

CHAIRMAN WALLIS: The strainer is all up in the top to the northwest or whatever.

MR. PETERSON: Right. Maybe we'll start using directions.

CHAIRMAN WALLIS: There is nothing down in the bottom at all?

MR. PETERSON: Correct. So the flow comes out and finds its way to the screen and really leaves that dead area.

VICE CHAIRMAN BANERJEE: But the debris never gets there.

MR. PETERSON: Correct. You are correct. The debris is generated predominantly inside the annulus. It is pushed down these doors.

VICE CHAIRMAN BANERJEE: And you take no credit for debris settling, which was my issue with

CFD, that it is not sufficiently --

MR. PETERSON: Because of the nature -- Well, for some other stations that has been done, but for this, given the elevated --

VICE CHAIRMAN BANERJEE: You are not going to present any of those to us.

MR. PETERSON: No. This is my only --

CHAIRMAN WALLIS: But one might suppose that quite a bit of the RMI doesn't make it to the strainer.

MR. PETERSON: Yes. RMI, yes, and that's also part of this trash rack concept, to keep it away from the bottom of the screen.

VICE CHAIRMAN BANERJEE: That may tumble around that portion.

MR. PETERSON: But the RMI is really not a head loss constituent to worry about. It's these other items.

VICE CHAIRMAN BANERJEE: As far as the other stuff is concerned, you don't drop it out anyway.

MR. PETERSON: No.

VICE CHAIRMAN BANERJEE: The rest of it is almost irrelevant then.

MR. PETERSON: Well, we --

VICE CHAIRMAN BANERJEE: What is relevant about this?

MR. PETERSON: Okay. Well, if you will notice, it says preliminary. This does not have the trash rack in. There's another run that is in process to quantify velocities at the trash rack, and I will get to -- in a few slides down, I will get to why we are doing that.

VICE CHAIRMAN BANERJEE: There's a problem with these calculations, if I might just make a general remark, is that these flows are being driven by differences in level.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: And these types of computer quotes do very badly when it comes to calculation of the free surface area. So for example, they have no free surface module in those. But what happens is that every time it goes past an obstacle, as you know, things have to go up and down.

So inherently, these are extremely inaccurate calculations. You may do this for fun, but they have --

MR. PETERSON: There is information, but I guess I wouldn't characterize it as "for fun." There was information that is used, and I will show you where it was used as we go forward here.

VICE CHAIRMAN BANERJEE: So if you go past a bridge, for example, the surface changes, you now.

MR. PETERSON: Right. And this is --

CHAIRMAN WALLIS: Well, if you get shooting flow, then you get all kinds of stuff.

MR. PETERSON: This is even -- you know, as far as the grid, the floor has a relatively steep slope on it also here. You know, that is why there is not even a straight shot across the floor here.

VICE CHAIRMAN BANERJEE: The floor is not flat.

MR. PETERSON: Sloped in the annulus also.

CHAIRMAN WALLIS: Which way is it sloped?

MR. PETERSON: I should have known that.

CHAIRMAN WALLIS: Slopes outwards or something?

MR. PETERSON: Toward the sump. So that was part of our concern.

CHAIRMAN WALLIS: Slopes toward the sump?

MR. PETERSON: Toward the original sump. So that was part of the concern on making sure the outermost screen is still submerged.

VICE CHAIRMAN BANERJEE: So your concern was to make sure the screen remained submerged?

MR. PETERSON: Right. You want to make the screen as tall as possible to minimize the real estate, but you have to also cope with that. I mean, it's just another design consideration.

CHAIRMAN WALLIS: Well, if these velocities are like this, the velocities to the old sump could have been fairly high, seems to me.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: In fact, one of the things that might be of concern here is that, if these calculations are indicative of something, that the debris comes primarily with the flow. So it would reach some part of these strainers, whereas the other part of the strainers would be relatively inactive, because the velocities --

CHAIRMAN WALLIS: Until the first ones get caught.

VICE CHAIRMAN BANERJEE: Until they get caught. But that is a different calculation. Right? That would be slowly changing in that some part of it would get clogged, and then the flow would be direct.

MR. PETERSON: The fun you just mentioned just went up exponentially if you started running all those cases.

VICE CHAIRMAN BANERJEE: And, certainly,

you wouldn't want to do it with this code.

MR. PETERSON: I know. Yes.

VICE CHAIRMAN BANERJEE: You would probably do it with something that handled the free surface.

MR. PETERSON: Yes. Okay, next slide.

So this is also something a little unique to the Salem station. I mentioned that the fiber has a size distribution of small, large, and intact. So the concern was, if I trap pieces of these bigger pieces of fiber, do they erode?

The original SEI guidance had a 90 percent erosion factor. So remember when I was talking about these zones of influence. It's sort of -- It really penalized you. You had these very, very large zones, and then you hit yourself with this large erosion factor.

We thought there was some big benefit to go after there in parallel with the testing that was going on. So we did some plant specific testing. We developed pieces of Nukon and Kaowool in the size distribution.

I know early on there was concerns, do you bake these things? We baked them for six hours at 600 degrees, and we used the velocities in the CFD analysis to get us a flavor of the velocities we would expect in the containment, so we could look at these erosion parameters. Next slide, please.

VICE CHAIRMAN BANERJEE: Let me ask you one question.

MR. PETERSON: Sure.

VICE CHAIRMAN BANERJEE: The reason you went down to 7D or 8D or whatever you did was because you had stainless steel coating on your Nukon. Right?

MR. PETERSON: Stainless steel jacketing.

VICE CHAIRMAN BANERJEE: Jacketing. That's what I mean.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: So that was protecting.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: Otherwise, you would do 18D or 17D, whatever that is.

MR. PETERSON: Yes. We matched with the testing that was going on, and we did both of these again. Both of these activities in parallel, some way to reduce the Nukon load. You've heard, and I think you are well aware, that these fiber loads are one of the bigger problems. So these are two parallel paths, and it turns out we plan to use both of them.

So this slide shows the test facility.

CHAIRMAN WALLIS: What is being eroded here?

MR. PETERSON: It's samples of Nukon and Kaowool. The next slide after this I will --

CHAIRMAN WALLIS: What do you mean by being eroded then?

MR. PETERSON: It's samples -- If you go here, these are baskets that are in the flume. So these are pieces of insulation that were dislodged due to line break. They are no the fines. So they are not going to move along right away, and they are going to tumble and move along the floor.

They may get caught up --

CHAIRMAN WALLIS: By erosion, you mean --

MR. PETERSON: Break down to -- they are all fines. Correct.

CHAIRMAN WALLIS: I see. Okay.

MR. PETERSON: And the original guidance had a 90 percent factor. We felt that was really a burden on us, and we felt some subsequent testing at plant specific flow rates would generate some meaningful answers, and this was that test.

VICE CHAIRMAN BANERJEE: But this flume has a fairly uniform velocity. Right?

MR. PETERSON: Correct.

VICE CHAIRMAN BANERJEE: So if you had, say, these chunks of stuff coming out, and flow turned, as it does in your containment if you go back to this picture there, you tend to get accumulations of material sitting on the floor in those sort of -- what are obviously vortical regions that there isn't much action going on.

So those would move much more slowly, and they would generate a lot of fines probably. That is a function of time. I don't know.

It's a difficult calculation to base on just the flume experiments. That's all I'm saying.

MR. PETERSON: Well, the original data was some testing at the University of New Mexico. They ran it for a few hours, and figured out an erosion rate and then integrated it for 30 days. That's where the 90 percent came from.

We used the CFD. We used the highest velocities we found in the CFD analysis, and we put those in the flume. We thought that more than bounded anything else that would be out there.

So these are velocities substantially higher than what would be needed to tumble the insulation, and we thought, well, this was indicative of a piece of insulation either getting trapped somewhere or, hopefully, getting trapped on our debris interceptor.

VICE CHAIRMAN BANERJEE: Depends what is causing the --

CHAIRMAN WALLIS: The uniform velocity doesn't really do anything, does it? It just carries it along. But these vortices could do something different altogether. Is this an issue anyway?

VICE CHAIRMAN BANERJEE: This is in a basket. I mean, how much of an appeal do you have to make to this erosion to save your skin here?

MR. PETERSON: Not that much.

VICE CHAIRMAN BANERJEE: So you don't care.

MR. PETERSON: Well, I mean, we -- The 90 percent is -- and we are using this, but --

VICE CHAIRMAN BANERJEE: Can you live with 90 percent?

MR. PETERSON: Probably not.

VICE CHAIRMAN BANERJEE: So what is the amount that you --

MR. PETERSON: If I show you -- Well, I'm not going to in this public meeting present the actual results, but we'll show you a few more slides, and then let's get back to it. But we ran these tests, for example, in these baskets, and we experimented with ways to run the tests.

We put them on little spikes, and we did some stuff, and we thought the basket was the best idea in that it somewhat tumbled like a dryer, and we ran these 10 days, and the erosion -- after there is an initial kind of puff kind of cleaning process, the erosion term is not very great as a function of time.

VICE CHAIRMAN BANERJEE: So what --

MR. PETERSON: You've heard 30 days as kind of our goal here and, like I said, we ran these. I have a slide. I forget if it's 10 or 12 days, but we ran these -- 10 days. We ran these quite a long time.

CHAIRMAN WALLIS: These things are tumbling around in this cage all the time?

MR. PETERSON: A little bit, but at this velocity they don't move that much. They really don't.

VICE CHAIRMAN BANERJEE: So how much credit do you get for this reduction in the erosion rate?

MR. PETERSON: It was significant.

VICE CHAIRMAN BANERJEE: You don't want to say it in a public meeting. You want to close the meeting eventually at the end?

CHAIRMAN WALLIS: Well, you claimed it. Did the NRC accept it?

MR. PETERSON: It's -- Yes, it's like 20 percent rather than 90 percent. It's down to the 20 percent.

VICE CHAIRMAN BANERJEE: So it's 20 percent rather than 90?

MR. PETERSON: Yes.

CHAIRMAN WALLIS: That's a big difference.

MR. PETERSON: Yes.

CHAIRMAN WALLIS: Has this just been a claim so far or has it bee accepted by the staff?

MR. PETERSON: I don't believe the staff has.

CHAIRMAN WALLIS: Nothing has been accepted.

MR. SCOTT: Mike Scott, NRR. Remember, we have not seen this information.

CHAIRMAN WALLIS: Oh, you haven't seen it yet?

MR. SCOTT: This particular licensee is fortunate enough to be an audit plant. So we are going to be seeing them in -- what is it? -- October.

Right? So we will have more information for you after that.

CHAIRMAN WALLIS: You might have some questions about this tumbling and erosion?

MR. SCOTT: Yes.

MEMBER ABDEL-KHALIK: But what is the break-up mechanism?

MR. PETERSON: The original is the energy from the jet, and now --

MEMBER ABDEL-KHALIK: But in this process, what is the break-up mechanism?

MR. PETERSON: We are envisioning as insulation that moved down these stairwells and --

MEMBER ABDEL-KHALIK: I mean, if you look at that, you know, small particles being generated because of break-up of a large pieces, what is the break-up mechanism that separates these small particles? Is it sheer?

MR. PETERSON: I believe it's some basic sheer on the outside, yes.

MEMBER ABDEL-KHALIK: So if that is the case, wouldn't that be controlled by velocity gradients rather than velocity?

MR. PETERSON: Well, now we are back to the let's try to predict velocity gradients in the pool.

CHAIRMAN WALLIS: It isn't controlled by velocity at all. It's by tumbling against solid surfaces that it gets broken. So rattling around in this cage, it's collisions with the cage that break it, isn't it? Aren't the forces much bigger that way?

MR. PETERSON: There is this terminology, and I've heard -- You know, I was here. As I heard the discussion earlier today of incipient tumbling velocities.

For Nukon, I believe it's .12 foot per second. We are using velocities five times that in this. We feel that the justification is in the substantial increases on the LOCA velocity. Relative to, one, what it would take, the stuff would just move along, and we are envisioning it got stuck somewhere and, therefore, had the opportunity to erode.

We are also envisioning it got stuck at the location within the containment that had the largest velocity, and on a volume basis that's an extremely small spot. It's right around those accumulators, and we are eroding them there.

We eroded these for a long period of time, and saw a substantial reduction.

VICE CHAIRMAN BANERJEE: What happened in the New Mexico test? You said that --

MR. PETERSON: They had a couple of data points. It was in a pool, and they measured -- and this is from memory. It was out a few hours, and they measured the before and after, and got a loss, a material loss, for that time, and then did an extrapolation to 30 days, and that wa s--

VICE CHAIRMAN BANERJEE: This was a chunk of some --

MR. PETERSON: They were samples that the University of New Mexico had. Right.

VICE CHAIRMAN BANERJEE: And they had it in a moving fluid or --

MR. PETERSON: It was in a pool.

VICE CHAIRMAN BANERJEE: It was just sitting there?

MR. PETERSON: No. It was in a moving pool, a recirculation. It was meant to model a recirculation pool.

VICE CHAIRMAN BANERJEE: And this was in the Los Alamos report? I don't remember that.

MR. PETERSON: No. This was a separate NUREG from the University of New Mexico. I don't have those numbers with me.

VICE CHAIRMAN BANERJEE: It wasn't in

those -- It was separate?

MR. PETERSON: It was in also in the knowledge base NUREG that was put together. This stuff is all several years old.

VICE CHAIRMAN BANERJEE: So, you know, that's fine. I would appreciate the reference to that.

MR. PETERSON: Okay.

VICE CHAIRMAN BANERJEE: In any case.

You were trying to build up a larger database, if you like, experience with this type of phenomena to augment what was there with the New Mexico experiments. Right?

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: You used -- did you use the same sort of treatment that they used, or different?

MR. PETERSON: I really can't speak for how they prepared the samples. Like I said, we baked our samples, indicative of an insulation that was on a hot pipe for 20 years, to provide -- There is well known literature data that there is a breakdown of the binder material on this insulation. That happens at temperature. When it is installed, they do this to off-gas it.

MR. LEHNING: This is John Lehning of the NRR staff. What Bob was talking about was, I think, published in around 2002, and it was an integrated debris transport testing. That debris was a little bit different. Like he said, it was in a pool, and they measured quantities of debris. This is just blocks of that fiber, small pieces.

So they measured this debris before and after, and then the missing quantity was attributed to erosion. It wasn't controlled cubes of debris in baskets in that case.

VICE CHAIRMAN BANERJEE: But they were lying on the bottom?

MR. LEHNING: That is correct.

VICE CHAIRMAN BANERJEE: And they were exposed to unit directions or more chaotic?

MR. LEHNING: It was not unit direction. It was in a pool, and there were different structures in there to model walls of internal compartments of the containment.

VICE CHAIRMAN BANERJEE: Yes.

MR. LEHNING: And there was turbulence, I believe.

VICE CHAIRMAN BANERJEE: Right. Yes. So it would be a little different from this, but I mean, I don't know which is closer to your physical situation, but the problem is that, if you look at the geometry of this, it's quite a complicated -- I mean, there are three river-like spots, but there is quite a lot of obstruction of the geometry.

CHAIRMAN WALLIS: I think you worry about if it got caught in an eddy and was banging against the wall many, many, many times.

VICE CHAIRMAN BANERJEE: There are regions of -- vortec regions.

CHAIRMAN WALLIS: Well, you could talk about this forever, seems to me, without ever resolving it. We should move on.

MR. PETERSON: Okay, we will.

VICE CHAIRMAN BANERJEE: But it is a fairly substantial credit.

CHAIRMAN WALLIS: Oh, yes. I think it is a thing to be questioned, but we should move on. We are not going to resolve it here until we do the right test.

VICE CHAIRMAN BANERJEE: No.

MR. PETERSON: Next slide, please. I guess we did that one already.

CHAIRMAN WALLIS: Where are we now?

MR. PETERSON: Why don't we get to Slide

30. So after the erosion testing, we did some screening tests to design a trash rack/debris interceptor, the device that you saw the photos of, and we added RMI debris into this test matrix.

We looked at vertical plates, just with grating. We looked at vertical perf plates, and we will show you what we came up with.

This was really meant to start from the test data that was available in the literature, once again from tests at the University of New Mexico, for lift over curbs. So the data was out there that, if you had a jump over a curb, there was a certain debris retention capability, and we wanted to make use of that. Next slide.

CHAIRMAN WALLIS: Was the idea that you put this right across the flow passage, and then the fluid has to go over the top when it gets --

MR. PETERSON: Yes. This is like the trash rack that was shown in the photos earlier installed. This is roughly nine inches high, a three/four inch overhang there, and it goes around the perimeter of the screen near the floor to keep this debris that is sliding along the floor off the screen.

CHAIRMAN WALLIS: It goes on the floor where the strainers are?

MR. PETERSON: Yes. Yes, we showed you a photo earlier. We could run back.

VICE CHAIRMAN BANERJEE: Is it on both sides or just on one side?

MR. PETERSON: Just the one and the two ends.

VICE CHAIRMAN BANERJEE: Fifteen. Is that right?

CHAIRMAN WALLIS: Fifteen?

MR. PETERSON: Fifteen or 16, if you go back. Sorry.

CHAIRMAN WALLIS: Well, what do I see? I don't see anything there.

MR. PETERSON: Right on the floor. You see the pillars? Right behind them there is --

CHAIRMAN WALLIS: Oh, that's it. That's it there.

MR. PETERSON: Yes, that grating.

CHAIRMAN WALLIS: Okay. You talked about it then. This doesn't look quite like this thing.

MR. PETERSON: No, it doesn't. This was what was used for the testing. Now we feel that the actual grating offers additional resistance.

CHAIRMAN WALLIS: It's like a pre-strainer, really, because the fluid has to -- The stuff on the floor has to go through there to get to the strainer.

MR. PETERSON: Or over it. As it starts clogging up, it's -- It becomes this curb.

CHAIRMAN WALLIS: But conceivably, all the RMI will get caught there.

MR. PETERSON: If it transported that far.

CHAIRMAN WALLIS: If it gets that far?

MR. PETERSON: Right. And if it didn't, that's fine, too.

CHAIRMAN WALLIS: Okay.

MR. PETERSON: Okay.

CHAIRMAN WALLIS: Another thing to try to model, though.

MR. PETERSON: So Slide 32, just a photo from the test rig. This was a cable test, somewhat as expected, a triangular debris pile. As we put in more, it backs up, and we would determine threshold velocities.

CHAIRMAN WALLIS: Do all these things, but then how to quantify it in design is another question. How do you actually predict how much is going to get caught?

MR. PETERSON: This is where we made use of the CFD, to work our test data with the CFD here to understand prototypical velocities in the plant and then apply those velocities in the test flow.

CHAIRMAN WALLIS: Okay.

MR. PETERSON: Next slide, 33. Thanks, John. So this is the debris load for both units, and we have repeated the generated numbers that I showed you earlier, and by "transport it," we mean transports to the strainer. You see, for example, on the Nukon, oh, roughly a 50 percent reduction.

VICE CHAIRMAN BANERJEE: The Transco RMI is -- because you are saying some will remain on the floor somewhere.

MR. PETERSON: Correct. The fines are what are moving along.

VICE CHAIRMAN BANERJEE: So but then you look at the Nukon. You've got half the Nukon coming out, and quite a bit of the Kaowool. Right?

MR. PETERSON: Correct.

VICE CHAIRMAN BANERJEE: What is the rationale for that?

MR. PETERSON: It is moving up in a simplistic way. It moves up to the debris -- the trash rack and is exposed to an erosive term there that, after 30 days, was indicative of these values.

VICE CHAIRMAN BANERJEE: So this is like

the tumbling that you were talking about?

MR. PETERSON: This is -- The output from that was used to justify this. Correct.

CHAIRMAN WALLIS: Okay.

MR. PETERSON: Other items that we didn't test: You will see basically no reduction, things like Min-K at the smaller numbers. We just carried them through.

VICE CHAIRMAN BANERJEE: Why is there a difference between U1 and U2? Maybe there isn't, but if I look at the Kaowool there, U1 it is 128, generated 37, transported; whereas, U2 it is 116 and 76.

CHAIRMAN WALLIS: It is more easily transported, for some reason.

MR. PETERSON: It has to do with its location.

VICE CHAIRMAN BANERJEE: Oh, I see.

MR. PETERSON: Some of these atypical insulations are not necessarily mirror images.

CHAIRMAN WALLIS: All right.

MR. PETERSON: Next one. So the last analysis was the chemical effects analysis. Now this uses the WCAP-16530 that Westinghouse had presented in the morning. So this is the execution of the spreadsheet.

At this time, the later discussion regarding possible inhibition, we have not credited. So this is the base value, if you would, out of the WCAP. Next slide.

As Kiran mentioned, sodium hydroxide buffer, approximately 48 minutes of spray duration, relatively high; spray pH, followed with onset of recirculation for 30 days.

The maximum sump pH long term is 8.4. We did do sensitivities regarding the pH. We used maximum sump temperature profile to maximize any of the corrosive effects.

CHAIRMAN WALLIS: So you have a prediction somewhere of the amount of aluminum calcium and silica?

MR. PETERSON: Yes.

CHAIRMAN WALLIS: We are going to get to that?

MR. PETERSON: Yes. This slide. One thing you will hear about later when we do the chemical testing, the value of that we analytically predict -- we will call that the 100 percent value. Because of some of the uncertainties in the ongoing REIs and discussion, we have actually put a margin on there, and we are using what we are calling 140 percent of our analytical value when we do our chemistry tests.

This has, in addition, all the conservatives, and we have heard in the Westinghouse discussion. The big thing is this is the three-day integrated chemical load.

VICE CHAIRMAN BANERJEE: So this is based on the correlations?

MR. PETERSON: Yes, that you discussed earlier today. Correct. And at this point, we are assuming all the precipitates happen, time zero dropout, and they are all available as a debris load.

The values for this station, sodium silicate, 571 kilograms, and the aluminum oxyhydroxide, 17 kilograms.

VICE CHAIRMAN BANERJEE: So you are assuming the precipitate is out?

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: Before it arrives at the screens?

MR. PETERSON: It is the precipitant that is available as a debris load in front of the screen.

CHAIRMAN WALLIS: On the screen?

MR. PETERSON: It is in front of the

screen.

CHAIRMAN WALLIS: Precipitate means it's on the screen. It's a confusing term.

MR. PETERSON: Well, I want to call it -- It's in front of the screen.

CHAIRMAN WALLIS: In front of the screen?

MR. PETERSON: Well, we don't pack it on the screen. We put in a test loop in front of the screen, just like any other debris. You dump it in as close to the screen as you can, and Dr. Blumer will get into all those details.

MEMBER ABDEL-KHALIK: Just for my own information, you update this calculation over the 30-day period?

MR. PETERSON: It's an integrated value over the 30-day period.

MEMBER ABDEL-KHALIK: So you don't march in time, taking into account time variations of both pH and temperature. How do you do that?

MR. PETERSON: Yes, we do. The spreadsheet allows -- that is one of the inputs, is a pH transient and a temperature transient, and then the debris load. You put that in, and you determine the amount of precipitants after 30 days. But as the people from Westinghouse pointed out, the ability is in there. You could stop it at five days. You could stop it and capture the answer at anytime, and depending on the results of the test, we had those plans. We just so far haven't needed to do those.

MEMBER ABDEL-KHALIK: So typically, how does the pH change with time over a 30-day period?

MR. PETERSON: We are using limiting values. For example, we know, depending on the debris load is a higher or lower pH conservative, and we have run studies to determine that.

So, for example, your calculation -- Your analytical value, your analysis for long term pH, may be a pH between 7 and 8 1/2, as an example. You would make runs at 7. You would make runs at 8 1/2, and you would understand the sensitivity.

In a plant like Salem that has a lot of different sources, that was the best way to go. If you had just limited sources, you could look at the available data and determine should you bias the pH high or low, as an example.

MEMBER ABDEL-KHALIK: Thank you.

VICE CHAIRMAN BANERJEE: Now the last bullet you have, which is -- I want to get back to that -- primary precipitates in the post-LOCA sump pool, 371 kilograms of whatever at 17 kilograms of oxyhydroxide.

This is coming out of the calculation you just talked about?

MR. PETERSON: Yes. This is the results of that calculation. It is the execution of the WCAP 16530.

VICE CHAIRMAN BANERJEE: Okay. And these precipitates are then somehow ratioed and put appropriately into the experiments that you will be talking about, but this is the total for your --

MR. PETERSON: For this plant, and if you think of it -- I had those debris tables earlier that we were trying to determine how many truckloads. This is another debris. Those were all given in cubic feet. These are in kilograms. They are scaling factors that are applied to go to the head loss testing.

VICE CHAIRMAN BANERJEE: And these are at whatever temperature and pH?

MR. PETERSON: These are long term, and typically we bring the temperature down, back down probably lower than the LOCA started, to get everything back out, everything that has dissolved as precipitate.

VICE CHAIRMAN BANERJEE: So how do you go from these numbers to the numbers that you then deliver for the experiments? How do you scale it down?

MR. PETERSON: Dr. Blumer can get into all that, but it is a scaling based on the screen area. So if you have 5,000 square feet of screen and you are going to test 50, you apply that scaling factor.

VICE CHAIRMAN BANERJEE: But now one of the real problems I see is that even your CFD analysis, for what it's worth, shows that there are only certain parts of the screen that actually see any velocity. Otherwise -- So that what is being delivered is being delivered to a fairly small part of the screen.

In fact, that is one of the points that I was saying earlier, that it is very hard to do a representative experiment if you don't have really reliable CFD. Unfortunately, the CFD is much less than reliable, because of what you are doing.

So what you end up with is -- If you look at this diagram here, let's assume for the moment that it is correct. So we do with that favor. But -- wherever that is. Yes, here. Much of the stuff is being delivered to the screen in those discolored tongues.

If you look at the areas, the rest of it is quiescent. Nothing is happening.

MR. PETERSON: Well, no, there's velocity through all those areas. It's just, due to the height, it is a relatively low velocity. On the lefthand side, you are passing an elevator, and there is a small area there, so a lot higher velocity. And then up on the other you will see -- The three white lines you see are the pedestals for the pressurizer relief tank. Once again, it occupies area, and you have a higher velocity through there.

These are also velocities right on the floor.

VICE CHAIRMAN BANERJEE: Well, without going into detail, the white sort of arcs are where the strainers are. Right?

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: Okay.

MR. PETERSON: Or walls or other devices.

VICE CHAIRMAN BANERJEE: Yes, but at least--

CHAIRMAN WALLIS: Some is coming in from the wall sides.

MR. PETERSON: Yes.

CHAIRMAN WALLIS: Some of the stuff is

coming in from the back side over here.

VICE CHAIRMAN BANERJEE: Right, right. But what I'm saying is that it is only where the velocities are significant -- let's say 0.09 or something -- because most of it is just blue, and I can't tell the difference between blue and --

MR. PETERSON: Blue and blue?

VICE CHAIRMAN BANERJEE: -- blue and blue.

MR. PETERSON: Right.

VICE CHAIRMAN BANERJEE: So it's hard for me to tell, but I'm assuming that most of the stuff which is being delivered are in these plumes which are light blue. Okay? Or green or yellow.

So now the strainer on the left at the ten o'clock position has reasonable coverage, let's say. Even on the back there is some delivery, and certainly about half of it is getting delivery in the front, but the strainer on the right is not getting all that much debris.

That was the point I was making early this morning when I said that it is very hard to do a test in representative conditions, because it's an iterative process. You can't really test the scale model of this unless you --

CHAIRMAN WALLIS: Well, let's say it

another way. Every strainer, every piece of strainer has different conditions. As you go around the arc, you get one which has a lot of stuff, some which may have no stuff, and some in between.

MR. PETERSON: Or another way to think of it is, as I block a portion of the strainer, the debris is going to move on to the next one, and it is going to balance itself out, which is --

CHAIRMAN WALLIS: Are you going to model all of that?

MR. PETERSON: The testing does, and we'll get to that.

CHAIRMAN WALLIS: Let's see if it does. Are you sure it does?

MR. LU: Dr. Banerjee, maybe I can add something here, from NRR staff.

I think that is related to most of the other strainer testing, so not even in particular a Salem test. Then as he indicated, that if you have average assume all the debris, it is going to approach all the surfaces uniformly. That's the conservative assumption for the helos testing, because if you have -- just as you pointed out, that a lot of debris will end up on a significant portion of the strainer preferentially only, and then the rest of the strainer may be just clean. If you have clean strainer surface, it will be very small.

So that's the principle, and that's one of the fundamental assumptions for the prototypical helos testing is to perform the areas of scaling, and then that's the -- You know, that's the assumptions that are used by most of the strainer vendors there, too.

VICE CHAIRMAN BANERJEE: Yes, and it may be a good assumption, but there are, unfortunately, another aspect of this that might occur. Imagine now that you have debris of different sizes. Extremely fine debris will be carried even with the very low velocities through the areas which are open.

The other debris will go and block the regions which are associated with the higher velocities --

MR. LU: That's right.

VICE CHAIRMAN BANERJEE: -- because you know, basically, there is going to be a size separation system going on. So what you may find is that you get these areas blocked off, some fine and some --

MR. LU: That's right.

VICE CHAIRMAN BANERJEE: And the fine debris all goes through the other part.

MR. LU: Well, if you have a preferential debris transported to certain portions of the strainer, that portion of the strainer will take the debris load first. Right?

VICE CHAIRMAN BANERJEE: Right.

MR. LU: So you have a significant accumulation of the debris on that portion, and then the rest of the strainer surface will take much less, no matter whether it's a fine or large chunk of the debris.

VICE CHAIRMAN BANERJEE: Right. So the way to do an experiment here that would be interesting would be to see if there is an entrainment effect of the fines, even at low velocities, through the open screen areas which are not being blocked by the coarse material.

So, you know, if you have one fine and one -- Let's say you have one relatively blocked area because of high velocity, one relatively open area because it has low velocity. The thick stuff only gets through this relatively high velocity area.

MR. LU: Okay.

VICE CHAIRMAN BANERJEE: The thin stuff is like a fluid tracer everywhere. Okay? So it goes everywhere.

CHAIRMAN WALLIS: Falls off in the core.

MR. LU: So if you look at the assumption then, the assumption is the uniformly distributed. For the fines it is also assumed it is uniformly distributed, and in that case they may have already taken into account this effect already.

CHAIRMAN WALLIS: We have to know what the vendor and what the utility proposes as a method. Otherwise, you can speculate forever about it.

MR. LU: That's right.

CHAIRMAN WALLIS: And I don't think we want to do that.

MR. PETERSON: In the next section, I will go into all the testing. You know, I seem to have gotten prematurely into the testing mode, and we should let Dr. Blumer do that.

CHAIRMAN WALLIS: We'll get to that.

MR. PETERSON: Yes.

CHAIRMAN WALLIS: And someday this closure arm which is going to be proprietary, because you are not going to tell us today all the sort of details of the numbers and how you actually moved the numbers.

MR. PETERSON: The numbers would be a stack of paper about this big.

CHAIRMAN WALLIS: You aren't going to tell us that today.

MR. PETERSON: Yes, there will be.

CHAIRMAN WALLIS: You are?

MR. PETERSON: Yes.

CHAIRMAN WALLIS: Okay.

MR. PETERSON: It's in the next section.

CHAIRMAN WALLIS: Well, let's get to it then.

MR. PETERSON: Okay.

MEMBER ABDEL-KHALIK: Can I just ask a question? To get that 371 kilogram and the 17 kilogram number, you presumably figured out the total surface area of aluminum components.

MR. PETERSON: Yes.

MEMBER ABDEL-KHALIK: And if you have done that, that means you know the total mass of these components. What does this 371 and 17 kilogram represent in terms of percentage? Is it a hundredth of a percent?

MR. PETERSON: I heard your question this morning, and I regrettably -- I had that slide in here. I deleted it. So I don't have that with me. I can provide that to you.

MEMBER ABDEL-KHALIK: All right.

CHAIRMAN WALLIS: But it's a small

percent?

MR. PETERSON: It's a small percentage, yes.

CHAIRMAN WALLIS: The ladder doesn't disappear. The ladder still is a recognizable ladder.

MR. PETERSON: Yes. You have taken a little film off of it.

CHAIRMAN WALLIS: Okay.

MR. PETERSON: But, yes, I do not have that with me.

MEMBER ABDEL-KHALIK: But I think it would be a good idea to know the order of magnitude of what we are talking about.

MR. PETERSON: That concludes my portion. So Dr. Blumer will talk about testing.

DR. BLUMER: Okay. On the next slide you see the scope of my presentation. I will talk a little bit about the design and the considerations of the layout, about the testing, and then about the overall calculation methodology and also the results that we've got so far, mainly for Unit One.

On the next slide, you see a typical layout. This is for Unit One. You see that we have a number of standard modules, and in between there where the "m" of modules is there, you have a little bit longer module, which is the 15 pocket long module. The others have 10 pockets in the flow direction.

This train of modules comes to a Z-shape duct at the end. We had to implement a Z-shaped duct because of constraints with the geometry of the sump. Then we come into the suction box where the two pipes of the RHR are taking suction.

CHAIRMAN WALLIS: Can I ask about the material that gets to the back side of the strainers near the wall, the outside wall.

DR. BLUMER: Well, that's the next thing I will -

CHAIRMAN WALLIS: Presumably, in some accidents it has to come around the ends. There isn't enough water on top of the strain.

DR. BLUMER: That is the beauty of the arrangement exactly, because the water has to flow over the strainers to get to the other side, because there is too much constriction on both ends for the water to go through.

CHAIRMAN WALLIS: But there are some accidents where you don't have that much water.

DR. BLUMER: Yes, we do have three inches as a minimum.

CHAIRMAN WALLIS: Over the top of the

strainer always?

DR. BLUMER: On top of the strainer.

CHAIRMAN WALLIS: For a large break LOCA, but not for all LOCAs.

MR. MATHUR: No, but for small break LOCA, you do not go into recirculation more --

CHAIRMAN WALLIS: Well, there must be some intermediate break where there is water on the floor, but it doesn't cover the strainers.

MR. MATHUR: We calculated 80 feet 10 inches to be the minimum flood level.

CHAIRMAN WALLIS: That doesn't always happen, does it?

MR. MATHUR: I don't know what kind of LOCA we are talking about.

CHAIRMAN WALLIS: Well, in the small break LOCA there is no water there. IN the large break LOCA there is a lot of water. There must be some intermediate size where there is an intermediate amount of water.

MR. GASPER: Joe Gasper, Omaha Public Power. In order to go to recirculation, you empty the entire --

CHAIRMAN WALLIS: That's right.

MR. GASPER: -- tank.

CHAIRMAN WALLIS: Therefore, it has to be. Okay. Just conservation of water.

MR. MATHUR: Yes. You do not turn over until you have --

CHAIRMAN WALLIS: You wouldn't pump -- You wouldn't start pumping unless you had that much water.

MR. MATHUR: That's exactly right.

CHAIRMAN WALLIS: That's obvious. Okay. Thank you. That's very clear.

DR. BLUMER: So if we look at these pictures, also the next slide which is almost a mirror image, the next slide has for Unit Two just a connection duct, due to this obstacle that we have there, and this just connects to standard modules.

CHAIRMAN WALLIS: Now the velocity in the connection duct is presumably quite high?

DR. BLUMER: No. It has been designed to have a reasonable head loss. We calculated the head loss, and it was in reasonable limits.

CHAIRMAN WALLIS: A few feet a second or something?

DR. BLUMER: It's got the same width like the standard models inside, more or less. I'll show you the standard module picture afterwards.

I just want to show you still with this

layout here what we do for testing. We take a slice of this, and we assume that we can test only with one side of the strainer. So flow to one side. This means that for the other side we are very conservative.

For the wall side, the water actually has to flow over the strainer, and the strainer itself acts as a big curb or a big trash rack, preventing the debris to also go over the obstacle of the --

CHAIRMAN WALLIS: Unless it's fine, unless it is very fine.

DR. BLUMER: So we did testing for another U.S. unit about exactly this arrangement where we have one side against the wall, and we had strainers, test strainers, with both sides, and we saw a significant reduction of head loss. So this shows that we have a very conservative test arrangement.

CHAIRMAN WALLIS: Very low head loss, but perhaps more bypass of fine material.

MR. MATHUR: Which is exactly what I was saying.

DR. BLUMER: But I understood that we have quite a margin in downstream effects here of fibers.

MEMBER ABDEL-KHALIK: What is the scale on this picture? What is the space between the back of the strainer and the wall?

MR. MATHUR: I don't remember. I should know that.

CHAIRMAN WALLIS: It's a couple of feet or something, typically, like that?

DR. BLUMER: It's about -- The width of the strainer modules is about four feet, roughly.

MEMBER ABDEL-KHALIK: This is a fairly substantial gap, like two feet.

DR. BLUMER: Yes, sure. The modules are about four feet, I think, and this gap is about two feet or something like that.

CHAIRMAN WALLIS: In figure 41, it actually looks less. I don't know how to scale that is, though.

MR. PETERSON: You've got to get around the columns you will see on like Figure 39.

DR. BLUMER: Let's go to Figure 40 now. There you see a module. This is the standard module with 140 pockets, 70 pockets on each side. You see that the cover on top is all unperforated. We have not done that like this for all the U.S. utilities. When we have a lot of water coverage, more than a foot or two feet, then we have usually also perforated area on top.

Like this, we prevent any air vortexes, and we have done testing to show that air vortexes in these conditions do not occur.

VICE CHAIRMAN BANERJEE: Now in the pockets that you are showing, are you going to show us this in more detail, each of these, what these pockets look like?

DR. BLUMER: I have a slide later on which shows a pocket, yes.

What you also see on this slide is the fixation to the floor. We have bolts that are adjustable, and with these little bolts that you have beside them, you can adjust to the floor, to the floor level, because it is not perfectly even, the floor; and we can also locate the location of rebars. The rebars can be detected, and then we can choose the location with this turning plate that you have there that we can not hit the rebars in the concrete.

Of course, you have these feet on both sides of the module. They are only shown on one side here. In the middle we have the central duct for the water, and we do calculation of this head loss in the central duct as well. I'll talk about this later on.

In the next slide, we see the last module in the flow direction and the Z-shaped duct, and then the suction box.

MEMBER ABDEL-KHALIK: What happens if this Z-shaped duct were to fail?

DR. BLUMER: Due to what reason?

MEMBER ABDEL-KHALIK: Is it seismically qualified?

DR. BLUMER: Oh, sure. Yes. Well, we have taken out all the slides about the structural qualification, because we wanted to reduce the total number of slides. But we have loads of differential pressure, the maximum that you can expect, and then seismic loads, OBE and SSE, and we have qualified this, including some loads of the water acting on the structures, not only the structures' weight itself but also the interference fluid structure interaction and so on. So we have qualified this.

MEMBER ABDEL-KHALIK: Thank you.

DR. BLUMER: The next slide shows you an optimization that we did especially to have acceptable head losses and to gain margin for the overall head loss. We put in veins that you see in the kinks of this Z-shaped box, and you also see a defuser to the left of it. This defuser allows us to regain some of the dynamic water head, and as we go into the box there is another -- a beam that goes across.

We made the whole CFD calculation to see what the head loss would be with and without these veins in the defuser. So we have chosen for Unit One to implement these already in the last outage, and I will show you the CFD calculations that we have used.

CHAIRMAN WALLIS: There is no screen in the box? The box is just a box with a whole in the bottom to go into the pump? In the corners of the box you could get debris accumulating past the bypass debris.

DR. BLUMER: I'm not sure I understand your question.

CHAIRMAN WALLIS: It's a two-phase mixture in the box. There's the water and there is the fine particles that came through the screen, and the velocity isn't very high in the box, is it?

VICE CHAIRMAN BANERJEE: The velocity is fairly high.

CHAIRMAN WALLIS: So you think everything is perhaps stirred up enough?

VICE CHAIRMAN BANERJEE: Yes. I don't know if it will be -- There could be dead regions.

CHAIRMAN WALLIS: That's right. So there may be piles in the corners. Okay.

VICE CHAIRMAN BANERJEE: Growing piles.

MEMBER ABDEL-KHALIK: The cross-section is the bottom?

DR. BLUMER: We'll have to scale it. I don't have the numbers and the drawings with me.

MEMBER ABDEL-KHALIK: I mean, roughly. Are we talking about five foot square?

CHAIRMAN WALLIS: More than that.

DR. BLUMER: It's about eight feet long and maybe four feet wide.

CHAIRMAN WALLIS: Looks like a pick-up truck bed or something.

MEMBER ABDEL-KHALIK: The cross-section is about 30 square feet?

DR. BLUMER: Well, I mentioned also that the fluid velocities are very low in there, and we can see that from the CFD calculation, which I will show you just now.

MEMBER ABDEL-KHALIK: This is just a way to geometrically connect one side to the other, because you have to avoid some obstacles?

MR. PETERSON: This is the original hole, the original sump, and now we have this box to connect to it and to seal it up. It's a box on top of a sump.

VICE CHAIRMAN BANERJEE: That's why they have this weird V-shaped --

MEMBER ABDEL-KHALIK: To connect to it. Okay.

MR. PETERSON: And then out of the sump are the pipes that go out to the pumps.

VICE CHAIRMAN BANERJEE: And you are trying to lose as little head as possible.

DR. BLUMER: Right. Yes. So Slide 42 shows you the goals, as I said already, that we wanted to optimize the load.

CHAIRMAN WALLIS: Is there any air in this box?

DR. BLUMER: No. It is --

CHAIRMAN WALLIS: Free surface on top, isn't it?

VICE CHAIRMAN BANERJEE: What happens if it is not completely full?

CHAIRMAN WALLIS: Is it full of water, or what is it? Is there air on top of the water in the box?

DR. BLUMER: The air would go out.

MR. PETERSON: It is submerged.

DR. BLUMER: It is submerged, yes.

CHAIRMAN WALLIS: Are you sure? Well, is it full of air when you start this? Where does the air go that is in the strainer to start with? The Z-shaped duct comes down. I would think there would be a lot of air left behind in the --

DR. BLUMER: The modules are on the same level as the suction box.

CHAIRMAN WALLIS: It comes out through the strainers. It comes out through the top.

DR. BLUMER: Right. As you fuel up, during the injection?

CHAIRMAN WALLIS: Through the top of these pigeonholes here. That's where it comes from. Okay.

VICE CHAIRMAN BANERJEE: Oh, they closed off the vents on top.

CHAIRMAN WALLIS: And it comes out through here.

DR. BLUMER: Well, as you have the injection phase, the water level slowly rises, and the water gets out, but the top pockets -- You have no flow yet in this.

The goals, as I said before, is the optimization of the flow geometry with veins and diffuser and minimizing the head loss.

VICE CHAIRMAN BANERJEE: Do these pumps need to be primed or are they self-priming, or how does it work?

MR. MATHUR: I'm not sure, but we had

recirculation. Those recirculate --

CHAIRMAN WALLIS: There is a problem in some of these pumps, or there has been, with air in the suction line to the pump. I guess that's been sorted out now. There has been a problem with some pumps.

Well, if you don't remember that, you can run the pump and nothing happens.

VICE CHAIRMAN BANERJEE: I've done that many times in my life, unfortunately.

DR. BLUMER: Okay. The method that we used to determine the head loss in this region was CFD modeling of the whole geometry from the last module up to the suction pipes in the sump itself. So we did steady state and transient computations.

We saw that there was some instability of flow, and that is why we chose to use also transient computations, and for the head losses that we later on use is the maximum of the fluctuation affecting head loss.

We modeled the entrance of the chemical effects on viscosity a little bit. Although we have turbulence regime, it is not very important, and we have looked at the two flow rates mentioned earlier.

In the next slide --

VICE CHAIRMAN BANERJEE: What were the two flow rates? I have forgotten.

DR. BLUMER: 5,110 for Unit One, and 9,000 GPM for two-pump operations.

MR. MATHUR: There is one-pump operation and two-pump operation. That's what we are talking about here.

DR. BLUMER: And this is the basic geometry of the CFD model.

The next slide shows you the velocity distribution. You see that at the ends of the diffuser you see this beam that's in the way there. We modeled this beam as well to see some back pressure occurring, and you see that there is quite an efficient function of these veins that really take the flow around the corners of Z-shaped duct.

The next slide shows you --

VICE CHAIRMAN BANERJEE: What are the velocities? I can't read the slide.

DR. BLUMER: That's the maximum of the scale above there is 2.8 meters per second. Yes, meters per second, that should be. Yes.

CHAIRMAN WALLIS: Nine feet a second?

DR. BLUMER: Yes. It's quite a high velocity. That's why we chose to use these veins in the diffusers.

CHAIRMAN WALLIS: That's more than a foot of water.

DR. BLUMER: It was quite substantial, but if we wanted to reduce that, that would have been a big effort, and it would have been difficult to put it in, in the existing geometry of the whole containment there.

VICE CHAIRMAN BANERJEE: And what are the pressures? Again, I can't read the pressures.

DR. BLUMER: Let ;me see. That's Pascals, and I think the last to the right of the scale is 4,000.

VICE CHAIRMAN BANERJEE: Four thousand Pascals?

DR. BLUMER: Yes.

VICE CHAIRMAN BANERJEE: And on the left? It's not zero, is it?

DR. BLUMER: It's something close to zero, probably. I cannot read on my thing as well.

CHAIRMAN WALLIS: Anyway, it's all figured out. The NPSH they need is 25 feet or something like that?

DR. BLUMER: Well, anyway, I showed the results in the next draft. There, I have the head loss portions transferred from Pascals to feet. You see the two flow rates that we have, and with the plane geometry -- that means without veins and diffuser -- we have 1.32 and 3.95 feet. With the improvement that we have designed, we have 0.61 and 1.86, which gives us more than two feet for the two-pump operation. It is quite substantial what these things bring that we use for optimization.

So that s just something on the green side of the strainer, and I am going to tell you about --

MEMBER ABDEL-KHALIK: What do you mean when you say gives you more than two feet for the two-pump operation? Just allowing for the net positive suction head?

DR. BLUMER: Yes, for the overall head loss and then also for the NPSH margin, yes.

MEMBER ABDEL-KHALIK: Based on the 2 foot 8 inch --

DR. BLUMER: I'm just talking about --

MR. PETERSON: He's saying the reduction is two feet. He went from 3.95 to 1.86 by installing these turning veins.

MEMBER ABDEL-KHALIK: Oh, I see.

MR. PETERSON: That he reduced the head loss by two feet. So that bought us two feet to use for debris or chemicals or anything else.

DR. BLUMER: Then I come to the next slide with the test facilities. We have in Switzerland the small size vertical test loop, a large size horizontal test loop. They are both used for head loss testing, and then a multi-functional horizontal test loop. Here we have done quite a number of testing for chemical effects, as well bypass testing, transport testing, and flume sedimentation testing.

CHAIRMAN WALLIS: What you don't show here is the man with the bucket who pours the debris in.

DR. BLUMER: Yes, well, we have several of these people now, because we are doing such a lot of testing.

VICE CHAIRMAN BANERJEE: But CCI is not associated with Sulzer anyway.

DR. BLUMER: We were Sulzer originally in Switzerland in Winterthur, and 10 years ago we were sold to an American company, CCI in California, and we have the Switzerland location.

CHAIRMAN WALLIS: I went to see this, and I think one of the variables certainly is the way the man with the bucket stirs the bucket and pours the debris into this system.

DR. BLUMER: We have come quite a way for debris preparation as well. We use the mechanical stir. That is a mechanical drill with a propeller at the end, and we have seen through testing that there is a better way, and we use a water jet now to dissolve the fibers very much better into single fibers, which gives also a thin bed, if that occurs at all.

VICE CHAIRMAN BANERJEE: So you don't use a blender. I remember in the past people used blenders.

CHAIRMAN WALLIS: But the material sits around in buckets, doesn't it, before it gets poured in?

DR. BLUMER: It is put together -- All the debris is put together in a bucket with the water, and then we use a water jet to dissolve the fibers.

CHAIRMAN WALLIS: Stir it up. And you do that while you are pouring it in?

DR. BLUMER: Yes, partly, and then we fill up. Of course, if we have --

CHAIRMAN WALLIS: When we first saw it, there was a trowel used to get the mud out of the bucket. Now he uses a jet.

DR. BLUMER: Yes. We usually have several buckets also if we have a big amount of debris, so that we can really stir the whole lot, and we don't have a deep --

CHAIRMAN WALLIS: So you are try, I think, to be as conservative as possible, to stir it up more than it would be stirred up in the plant.

DR. BLUMER: Right.

CHAIRMAN WALLIS: Because it's very difficult. You can't simulate what happens in the plant, but you can try to be extra conservative.

DR. BLUMER: Well, what we try to do is all the debris that Bob Peterson was explaining that was transported to the screen that this is all fine fibers, completely fine, and not various classes of fibers.

VICE CHAIRMAN BANERJEE: I think the point I was making is, unfortunately, stirring makes a big difference in the sense that, if you stir it up too much, as Graham was saying, everything goes to the screen, and it's nice and uniform. But if you don't stir it quite that much, you could get some part of it going and blocking some part of the screen and the other part just going and passing through, or bypass.

It may not be a problem for this plant, but all I'm saying is that it could be a problem for other plants. Uniform stirring is not necessarily the worst case.

CHAIRMAN WALLIS: Uniform stirring is different from you have it in a bucket uniformly stirred. You pour that into a pool. What the contents of the bucket does now is not necessarily uniformly distributed.

VICE CHAIRMAN BANERJEE: No, I'm sorry. I thought you meant stirring up the pool as well.

CHAIRMAN WALLIS: You don't stir the pool, do you?

DR. BLUMER: No, no, no. We just -- of course, we get some waves and some --

CHAIRMAN WALLIS: Just all the way through here that does natural stirring. But you don't have a stirrer in the pool itself.

DR. BLUMER: No. No.

CHAIRMAN WALLIS: But when you pour a dense mixture from a bucket into a pool, it goes to the bottom and flows around, presumably.

DR. BLUMER: Well, we get sort of vortexes on the horizontal axis that go like this.

VICE CHAIRMAN BANERJEE: Vortexes are wonderful separators, actually.

DR. BLUMER: Yes, very slow vortexes.

CHAIRMAN WALLIS: IN a teacup.

VICE CHAIRMAN BANERJEE: That's the problem. All I'm saying is that you can get tight separation.

CHAIRMAN WALLIS: Well, the staff is well on top of all this, I'm sure.

DR. BLUMER: Okay. The next slide shows you the vertical small scale loop. I think we haven't used that very much after some initial testing.

The next slide shows you the university of Winterthur loop. That's quite a large loop, and we have separation plates that allow us to simulate the geometry of the plant that's as good as possible.

The next slide shows you --

VICE CHAIRMAN BANERJEE: This is the -- What is the laminar flow zone around strainer module mean?

DR. BLUMER: Well, what we usually have done for the French, for example -- this is the thing that shows how we have done it for the French. You see this pipe there with the holes in it? That's the pipe bringing in the water, and we have there a turbulent zone from these holes, and we have no sedimentation in this compartment. That's why we put in the debris.

Then the debris and the water would flow around this plate, this first plate, into the strainers with a relatively quiet zone there. That was the specification of the French. They wanted to have it done this way.

For the U.S. plants, we usually put the debris directly before the strainers, less sedimentation.

CHAIRMAN WALLIS: Were you doing the Salem tests when we visited you, or not? Do you remember?

DR. BLUMER: I think it was not Salem, no.

CHAIRMAN WALLIS: It was Salem?

DR. BLUMER: No. Actually, when you were in Winterthur, we didn't do actual testing which were valid for QA tests for any plant, I think, but a different one, yes. Yes.

VICE CHAIRMAN BANERJEE: I didn't know there was a university in Winterthur.

DR. BLUMER: There's different levels, I think, at a university where you do a BSE, and then in Zurich the Federal Institute of Technology, you make a Master's degree.

CHAIRMAN WALLIS: That's an offshoot of Zurich.

DR. BLUMER: Not really. It has different roots in Winterthur.

VICE CHAIRMAN BANERJEE: It is not the ATR?

DR. BLUMER: No, no. The ATR is in Zurich, yes.

CHAIRMAN WALLIS: Much more practical than the ATR.

DR. BLUMER: Okay. The next slide shows you the multi-functional loop, and that is actually the configuration as we used it for the chemical testing. So you have some compartments before the strainer, and you see a typical strainer module with a certain number of pockets, for example, 10 rows high and four rows wide, and then the pump behind.

The water is brought back from the pump above in a part into the first compartment again. So you will see a better picture of this again later on.

VICE CHAIRMAN BANERJEE: So this is a once-through or the recirculating?

DR. BLUMER: This is recirculating. The older loops are recirculating.

VICE CHAIRMAN BANERJEE: So the fines get carried around?

DR. BLUMER: Right. Everything that goes -- except for the bypass testing. for the bypass testing, we captured the fines in a special screen where we brought back the water in the first compartment there, and then we took out the screen, the fine screen, later on, dried it and weighted it and analyzed it for bypass.

VICE CHAIRMAN BANERJEE: So the screen now is a submicron filter of some sort?

DR. BLUMER: Yes. It was. I don't know the size of the mesh anymore. I don't say a number, because I don't recall it, but it was considered fine enough to capture practically all the fibers and most of the particulates. But we tested mainly for fibers. Especially for Salem we tested with fibers only for bypass.

So the next slide shows you the different types of testing. You see small scale, large scale, bypass testing, and chemical testing, the last two being done on the multi-functional loop. The debris types are for the small scale and large scale the Nukon, Kaowool, particulates, RMI; and for the bypass testing, as I said before, we used only fibers.

CHAIRMAN WALLIS: the mix that you put in is the mix that you expect from the plant?

DR. BLUMER: Yes. Yes. We actually bounded it by extreme cases. We used only Nukon and then a mixture of Nukon and Kaowool, and we saw that the Kaowool was much more severe with respect to head loss.

CHAIRMAN WALLIS: You know, head loss things are rather peculiar. If you have -- if the Nukon all goes to the first few strainers and some of the other stuff goes down, it makes a thinner bed, it could be worse for head loss than if it was all mixed together; because sometimes a thin bed is worse than a thick bed with the same amount of particulates in it.

DR. BLUMER: I have a last column there, benefits of learning. We also learned that thin beds have not really formed. We couldn't see a head loss there with the thin beds, which was 1/8th of an inch. We also have seen that the RMI, which is actually, as we have learned before, is held up by the trash rack, but we didn't take account of this. So the RMI head loss was not important anyway.

MEMBER ABDEL-KHALIK: How is the head loss measured in this facility?

DR. BLUMER: Well, we have two little parts that go before the strainer and after the strainer, and we have a U-tube that we use normally for these tests. So this is a very accurate measurement, just by measuring the lengths. Then we also have a calibrated electric gauge that tells the head loss.

MEMBER ABDEL-KHALIK: So the elevation of the upstream tap is where -- I mean, you are saying you have 10 --

DR. BLUMER: At the mid-height of this vein, yes.

MEMBER ABDEL-KHALIK: And you are assuming that the pressure upstream of this thing is pretty much uniform?

DR. BLUMER: Yes. Well, you have the gradient from the gravity, of course.

MEMBER ABDEL-KHALIK: Right.

DR. BLUMER: But that is equal on both sides.

MEMBER ABDEL-KHALIK: But the outlet here doesn't seem to have the same cross-section as the inlet.

DR. BLUMER: Well, actually, this drawing is misleading that you have, this CAD drawing, because we have a taped connection between the strainer and the pump.

VICE CHAIRMAN BANERJEE: Is this the facility you are using primarily or that one?

DR. BLUMER: For chemical effects, it's

the third one, this one, yes. And the large scale one was used for learning and, as I said to you, we learned about sand bed effects, about RMI influence, about influence of the fiber type, that Kaowool would be more detrimental for head loss.

CHAIRMAN WALLIS: What type of testing are you going to use for engineering purposes?

DR. BLUMER: Well, the bypass testing was done in the multi-functional loop, and then the chemical testing.

CHAIRMAN WALLIS: When you calculate head loss in the plant following a LOCA in order to get NPSH, are you going to use the results from the large scale testing?

DR. BLUMER: No. We have decided to use the last MFTL testing, including the chemical effects.

CHAIRMAN WALLIS: From the chemical effects tests?

DR. BLUMER: Yes, because that includes everything. That includes the fibers, the particulates and the chemicals and also the RMI. So we have the totality of all --

CHAIRMAN WALLIS: -- distributed across that tall skinny screen?

DR. BLUMER: I'll talk about this.

MEMBER ABDEL-KHALIK: So if we go back to Slide Number 51, what does this picture really look like?

DR. BLUMER: Maybe we have a better picture later on. Fifty-nine, yes. Well, okay. Fifty-nine is actually showing better what we did for Salem. Fifty-eight is just a --

CHAIRMAN WALLIS: There is a bigger diffuser or whatever you want to call it.

DR. BLUMER: You see that there is a taped connection piece which joins to the pump there.

MEMBER ABDEL-KHALIK: The downstream pressure tap is located where?

DR. BLUMER: We have two different ones, one on this taped section and one before the pump.

MEMBER ABDEL-KHALIK: Before the pump?

DR. BLUMER: Yes. We looked at the velocity influence of that, and that proved to be acceptable.

MEMBER ABDEL-KHALIK: But if the cross-sections are the same, the difference form the hydrostatic head will be important.

DR. BLUMER: Yes, sure, but we checked with the velocity that we expected there, that this would be within the allowable difference. So the dynamic head was not important here. That was checked.

MEMBER ABDEL-KHALIK: No. That's not what I'm talking about. If you are measuring -- if you are putting your pressure tap at the mid-level elevation upstream, and you are putting the downstream pressure tap at the mid-level elevation of this smaller cross-section, there is a hydrostatic pressure difference between the two. Are you accounting for that?

DR. BLUMER: But your piping, the flexi-piping that goes to the instrument also is full of water, and the hydrostatic difference is taken care of by the piping that you have. There is no flow in this little piping. So you just have to make sure that your little pipes that connect up to the measuring instrument are full of water. You cannot have air in there.

CHAIRMAN WALLIS: There is no flow. The level is the same in the little piping.

DR. BLUMER: There is no flow, and you must make sure that there is no air pocket in there. That's clear.

VICE CHAIRMAN BANERJEE: And the other thing that you said is that the change in the velocity from the inlet to the outlet doesn't give you any significant velocity head difference.

DR. BLUMER: Can you repeat that?

VICE CHAIRMAN BANERJEE: You have a difference in cross-section area going from the inlet -- at least from what I can see in 58.

CHAIRMAN WALLIS: To the green arrow.

VICE CHAIRMAN BANERJEE: To the green. So just due to Bernoulli's effect, there will be some change in the pressure, static pressure, that you measure. I'm assuming that the velocity head difference is small then.

DR. BLUMER: Yes. It is very small. Yes.

VICE CHAIRMAN BANERJEE: So what is the fluid velocity going in there?

DR. BLUMER: I would have to calculate it.

VICE CHAIRMAN BANERJEE: Roughly.

DR. BLUMER: It's similar to the real situation in the plant, because it is scaled.

VICE CHAIRMAN BANERJEE: Point-one meters?

DR. BLUMER: Less than .1 foot, I think.

VICE CHAIRMAN BANERJEE: .03 meters per second?

DR. BLUMER: It's very, very -- Well, before the strainer it is completely negligible, and after maybe it is one millimeter or something like that. We measured also the clean head loss always, by the way, and it was negligible. So already without debris we should have seen this influence, and we always measured -- For every test before we started the test, we did a zero measurement. That means with a clean strainer.

CHAIRMAN WALLIS: By the way, maybe I should say my intention. It is now five o'clock. My intention is to just keep going.

DR. BLUMER: Okay.

CHAIRMAN WALLIS: Is that all right with everybody? Until we finish.

VICE CHAIRMAN BANERJEE: What is a typical pressure loss across the screen?

DR. BLUMER: Without debris?

VICE CHAIRMAN BANERJEE: Well, without debris and with debris. Start without debris.

DR. BLUMER: Without debris, it is, I think, maximum at 0.01 foot or something like this head loss, almost zero. Excuse me?

VICE CHAIRMAN BANERJEE: Can you give it to me in pascals?

DR. BLUMER: I have the head loss reports with me. So I could look it up.

VICE CHAIRMAN BANERJEE: So what is that,

.1 foot

DR. BLUMER: No, .01 foot about. It's almost not measurable within the grounds of the signal.

VICE CHAIRMAN BANERJEE: Okay. So the screen material or the strainers have almost no loss associated with them?

DR. BLUMER: Right.

VICE CHAIRMAN BANERJEE: And with the debris, what does it come to?

DR. BLUMER: This depends on the conditions. I'll talk about this later on.

VICE CHAIRMAN BANERJEE: But roughly. I'm just looking for a measurement.

DR. BLUMER: Well, about up to -- we measured up to five feet or something like this. It depends very much -- Oconee, for example, which is another plant which I won't talk much about, but they have head losses of .1 foot, including the green strainer cavity head loss and so on. So they have very, very low head loss.

CHAIRMAN WALLIS: Put enough chemicals in, you can make it pretty high.

DR. BLUMER: I doubt it there, because we have very little fibers there, which cannot capture the chemicals.

CHAIRMAN WALLIS: Once you get the fibers, though, you can then stop putting in particles.

MR. PETERSON: To answer your question, two feet is upper limit on the test at Salem, head loss.

CHAIRMAN WALLIS: So your NPSH you want is 25 feet, and you are looking at something like 2 feet pressure drop?

MR. PETERSON: The NPSH-R that was on the earlier slides is what is required by the pump. We will show you the limit. I mean, you got to subtract the friction losses and the static and all of those calculations. We just gave you the raw data for the pump on that early slide. We will show you later the limit.

CHAIRMAN WALLIS: We'll get to that then.

DR. BLUMER: Okay. So --

VICE CHAIRMAN BANERJEE: We never can fill up these pockets. With so much pocket area that these six truckloads or whatever --

DR. BLUMER: No. We can show you some pictures in another slide later on that you see the degree of filling of the pockets.

I'll talk a little bit about bypass

testing that we have done. We found out that some people use percentages of this bypass quantification. We have used another measure, because we found that there is a certain saturation of the amount that goes through a certain screen.

It means the saturation level is proportion to the screen area and, more or less, also a function of velocity through the screen.

CHAIRMAN WALLIS: You are off at the beginning before you build up the fibers.

DR. BLUMER: Right. Right. And so --

CHAIRMAN WALLIS: If you do build up the fibers.

DR. BLUMER: So we thought using a percentage is maybe not the best way of doing it, but we chose a certain amount of cubic feet of fibers per square fee of screen that goes through.

VICE CHAIRMAN BANERJEE: Is this some sort of a steady state that you get to?

DR. BLUMER: Right. Right. So once you get to certain fiber thickness on the screen, then nothing passes through anymore. Then later on you don't get more.

In the next slide 54, you see the fiber amount and the ordinate -- this value that I was talking about; and you see at the very low fiber amounts you also get low fiber bypass, and then you get with some scatter, more or less steady amount of fibers. Excuse me?

CHAIRMAN WALLIS: Are these repeatable experiments? If you do test two again, do you get the same value?

DR. BLUMER: There is some scatter, and then this -- I also depends, of course, whether -- what type of fibers you use, whether it's Nukon or Kaowool.

CHAIRMAN WALLIS: You're not bold enough to put an equation through this?

DR. BLUMER: No, but you can give quite easily an upper limit to that.

CHAIRMAN WALLIS: That's what they use for design.

DR. BLUMER: I have not used these results. So maybe --

MR. MATHUR: Five cubic feet. That's what we came up with, actually. Five cubic feet per foot square.

CHAIRMAN WALLIS: Out of 5,000 square feet. So that's .01?

MR. MATHUR: Yes.

CHAIRMAN WALLIS: So that's .01.
MR. MATHUR: One cubic feet per square --
CHAIRMAN WALLIS: So it's the top of the graph. You use .001?
VICE CHAIRMAN BANERJEE: It's not. Here it's about three cubed per thousand feet squared. So you could be --
CHAIRMAN WALLIS: Well, that's three, but here it's -- They could be low, yes.
VICE CHAIRMAN BANERJEE: These are representative. The issue that I was having was much more severe than this. I am still having this issue. As was pointed out, as a region gets blocked off, you keep moving the region.
CHAIRMAN WALLIS: So you get more bypass.
VICE CHAIRMAN BANERJEE: You get much more.
CHAIRMAN WALLIS: You should get much more bypass.
VICE CHAIRMAN BANERJEE: Much more bypass.
CHAIRMAN WALLIS: Right.
VICE CHAIRMAN BANERJEE: That's exactly what I was saying.
CHAIRMAN WALLIS: Yes. This is probably not acceptable as a predictive tool for the real

thing.

MR. PETERSON: But if you do it on a per square foot, every new section behaves just like the previous.

VICE CHAIRMAN BANERJEE: No, because you get an initial -- before it starts to build up the bed, the bypass --

CHAIRMAN WALLIS: And then to a saturation value.

VICE CHAIRMAN BANERJEE: Eventually, but it takes a while.

CHAIRMAN WALLIS: But maybe the fibers don't make it that far, just the fines, in which case it is going through all the time. Yes.

VICE CHAIRMAN BANERJEE: The other scenario.

CHAIRMAN WALLIS: Well, the staff is going to sort all that out.

MEMBER ABDEL-KHALIK: These tests are presumably run for a long time in order to reach --

CHAIRMAN WALLIS: The staff is very aware of all these problems. They are going to sort them all out.

VICE CHAIRMAN BANERJEE: The staff are aware that you might be getting fines popping through.

MEMBER ABDEL-KHALIK: To get back to the point that you were making at the beginning, these tests were done for a long time in order to reach this asymptotic value for the bypass?

DR. BLUMER: They were done until the water was relatively clear. So that we didn't expect the values to go up more anymore.

VICE CHAIRMAN BANERJEE: But the bypass was initially very high. Right?

DR. BLUMER: Right. That is why you get high turbidity at the beginning and then water clears off after a while. Yes.

CHAIRMAN WALLIS: Why was test 6 so high?

DR. BLUMER: We have to look at the test report. But you can clearly see that there is a function of penetration velocity at 0.05 inch per second. There is distinctly less bypass than at the high velocity.

CHAIRMAN WALLIS: What happened to Riot Zane? Didn't appear on the --

DR. BLUMER: Well, the Riot Zane is another thing which is not shown. I think there are only nine points in the other one as well.

CHAIRMAN WALLIS: Right. So it's not scale?

VICE CHAIRMAN BANERJEE: I want to ask you where you got the transient data on the bypass? Do you have --

DR. BLUMER: We have turbidity measurements, yes, and we have also samples taken at different times. Yes. We see a peak at the beginning, and then very low values --

CHAIRMAN WALLIS: We've seen that. We've seen that. We saw that last time.

DR. BLUMER: Well, I can show you the graphs of the test report, if you are -- So we definitely see a very high peak at the beginning and then almost nothing afterwards.

VICE CHAIRMAN BANERJEE: How long does that peak last?

DR. BLUMER: I can't pick a number now from my memory.

VICE CHAIRMAN BANERJEE: This is interesting, because if you, one, was actually doing a series here of peak calculation, you could probably take some of this into account as the screen blocked.

CHAIRMAN WALLIS: But we are not going to do that.

VICE CHAIRMAN BANERJEE: They are not going to do it, but if we wanted to amuse ourselves, we could.

CHAIRMAN WALLIS: You can do it.

DR. BLUMER: Okay. I come to the chemical testing after the bypass testing. We have a plant with the ICET Number 1 chemical condition. We have done testing at room temperature and also with simulated plants' pH, and as was mentioned before by Bob, we had WCAP methodology to come up with the total precipitate amounts.

What is perhaps special here is that we used the test loop as a particle generator, which has some advantages. We have avoided another step in the whole process. We don't have a particle generator. We would have to analyze the particle generator, then the loop.

CHAIRMAN WALLIS: So you used the particle loop as a chemical reactor.

DR. BLUMER: Right. Right. And I will explain that a little bit in the next slide then.

We also have precipitate concentration which is much closer to the real plant situation than if we would do it in a particle generator.

VICE CHAIRMAN BANERJEE: But the temperature is kept at room temperature.

DR. BLUMER: Right.

VICE CHAIRMAN BANERJEE: So the kinetics of the reactions --

DR. BLUMER: Well, we saw that what we put in, and I will talk about this later on, is immediately precipitate, and so we know that the flow -- the rate of the chemistry reaction is not really important here.

Then we've done pre-analysis by lab benchtop testing. We wanted to see the effect of tap water in the other debris, like stone flour that we have used, and we made tests of the filterability, the settling rate, the viscosity effect, and also the size distribution of the precipitates.

So after having done all these things, we started the procedure in the test loop. We put in all the debris, and we added then the boric acid to a certain concentration, and established a certain pH of four-point-something, 4.1, I think.

MEMBER ABDEL-KHALIK: How does the settling rate that you measured compare with the settling rate specified by Westinghouse for the surrogate debris?

MR. PATERSON: All of the data was comparable to the Westinghouse values.

MEMBER ABDEL-KHALIK: For the surrogate

debris?

MR. PATERSON: They had limits specified in their particle generator portion of the WCAP that they measured, and we compare to those same limits for filterability, settling.

MEMBER ABDEL-KHALIK: Okay. Thank you.

DR. BLUMER: We increased the pH and also started precipitation by slow addition of sodium aluminate, and then there was, as I said, immediate precipitation. So the chemistry reaction rate is not really very important here.

We have done similar steps, which I won't go into detail about, with calcium chloride and sodium silicate that was formed, and we did additional buffering to adjust the pH value according to the measured pH value in the loop.

VICE CHAIRMAN BANERJEE: This is a different surrogate procedure from Westinghouse's.

DR. BLUMER: Right, and maybe we have a lady here who can explain to you about this.

MS. PENROSE: Yes. There are a couple of things that are different. I'm Jeri Penrose with Sargent and Lundy.

The first thing that's different is that we wanted to do the precipitation in borated water.

Our feeling was that boron would likely absorb on the aluminum hydroxide and, if it did, we wanted that to happen.

It turns out that the boric acid helps us, in a way. We need a source of acid to counterbalance the alkalinity of the sodium aluminate, which was the source of aluminum, and by mixing the two, the pH worked out pretty well.

So we used the sodium aluminate. We added it first, so that we would precipitate some aluminum hydroxide. Next, calcium was added as a source of calcium. We didn't really expect calcium to do much, but it might participate in a calcium aluminum silicate instead of a sodium aluminum silicate. And since it was there in prototypical conditions, we wanted it there.

The last thing that we added was the silicate, sodium silicate. We added it last to make sure that we added it to an alkaline solution. We were afraid that, if we added it first, that to an acid solution we might precipitate colloidal silica.

So we had a particular order that we selected. The whole idea behind this was to add the masses of aluminum, calcium, and silica to match what would be seen in containment, and let the reaction do what it wants to do. Whatever it wants to make, it makes.

VICE CHAIRMAN BANERJEE: Is the sequencing sort of what one would expect in containment?

MS. PENROSE: It would happen simultaneously in containment.

VICE CHAIRMAN BANERJEE: Right. But would you precipitate colloidal silica in containment?

MS. PENROSE: No, because it is alkaline. by the time it cools enough, it's going to be alkaline.

VICE CHAIRMAN BANERJEE: So this is another alternative to the Westinghouse surrogate.

MS. PENROSE: Well, we didn't develop it as an alternative. It was actually done in parallel. At the time this work was done, the Westinghouse information was not available, and we actually started with predicting quantities from hydrogen generation calcs. You can get the amount of aluminum from that.

We took the ICET resolves and tried to use it, and only later when we went to do the test, the Westinghouse data was available. So we calculated the masses from the Westinghouse data, but the procedure, the methodology, we had developed in parallel.

So we don't have an issue with the

Westinghouse methodology. This is -- We did it this way; they did it that way.

VICE CHAIRMAN BANERJEE: Right, but there's some sort of a continuing program where there would be perhaps evaluation of effects due to radiolysis of water and other things, peroxides going on, which -- Are you going to do some sort of a parallel program to take into account some of those things which came out of -- The original peer review group comments came into this whole program, and now the surrogate, but on the other hand, there are some remnants of the peer review group comments which are going to be applied to make sure everything is okay with peroxides or whatever.

MR. PETERSON: We did not add any peroxide.

VICE CHAIRMAN BANERJEE: You didn't do anything like that?

MR. PETERSON: No. I'm not sure what the peroxide would do in this kind of a test.

VICE CHAIRMAN BANERJEE: It cannot do anything. I have no idea. I'm just saying you are cognizant of all that stuff, though.

MR. PETERSON: Sure.

MEMBER ABDEL-KHALIK: Are there any plans to duplicate these experiments using the Westinghouse surrogate to show equivalency?

MS. PENROSE Not that I'm aware of.

MR. PETERSON: As Jeri outlined, we made -- we've put some estimates together based on literature and ran these tests. I think they were probably the first non-vertical head loss tests in the industry, and this was prior to the Westinghouse data.

Now when the spreadsheet methodology became available, we, of course, checked those quantities and all of that test data relative to our estimates, and switched to that estimate. It was based on a lot more experimental data.

The exception, if you would, is just the choice to use the surrogate generator outside the loop. We had already embarked on this.

MS. PENROSE: And our thinking in doing it inside the loop was that it avoided a step of handling. We didn't want to double handle the precipitate. If there was going to be any flocculation or other changes from time of storage -- Now if you make the stuff and let it sit around for a couple of days -- It wasn't that we thought there would be a difference. We just wanted to avoid the question.

MEMBER ABDEL-KHALIK: I think my question should have been directed to Westinghouse as a way to validate their methodology.

MR. PETERSON: Yes. Other people have experienced aging issues with the surrogate. We have, obviously, minimized that.

DR. BLUMER: I just have an additional argument for using the loop instead of a particle generator. The WCAP tells you, you have to use at least 20 percent of the volume in the particle generator.

Now if you say we don't want to use the minimum, maybe 30 percent or so, then it would be a third of the water to add to the loop, which means the water level changes during the test enormously, which makes completely different approach velocities and so on.

So we found it also from this standpoint, it is much more practical to use the loop itself as a particle generator and not change the amount of water value and also the water level.

VICE CHAIRMAN BANERJEE: How quickly do these particles form?

DR. BLUMER: I think instantaneously.

MS. PENROSE: Immediately.

VICE CHAIRMAN BANERJEE: I see.

DR. BLUMER: Okay.

MR. PETERSON: One of the keys to our acceptance of this methodology was all the bench tests we did prior to going in the loop, and then there are also our samples extracted from the loop to make sure we are still getting in the loop with all the other debris, getting the characteristics we had anticipated.

DR. BLUMER: So I think we've looked at this slide of the --

VICE CHAIRMAN BANERJEE: The tests have now been concluded?

DR. BLUMER: For Unit One, yes. For Unit Two, we are still going to do it.

CHAIRMAN WALLIS: Although we have looked at it before, might we please look at it again, this one? You say debris introduction there, just before the strainer.

DR. BLUMER: Right.

CHAIRMAN WALLIS: Now it seems to me that those particles have some sort of a trajectory, and depending on just where you put them in, some may fall down preferentially at the top or part-way down or all the way to the bottom, depending on the velocity of the water and the size of the particle and exactly where and how you put them in.

DR. BLUMER: Yes.

CHAIRMAN WALLIS: It makes a difference how you put the debris in.

DR. BLUMER: Of course, it also depends very much how quickly you pour the bucket. So while you put the thing in, you create some turbulence, of course, and this --

CHAIRMAN WALLIS: The characteristics of the man with the bucket again becomes pretty important here.

DR. BLUMER: It's very difficult to really introduce that in a way that is predictable. It's very, very difficult to do that, because what you can do is put it in far away, but then you get the local sedimentation.

CHAIRMAN WALLIS: Well, what do the results mean if it depends on how you manipulate the bucket?

MR. PETERSON: If you think about in the plant, especially with Salem where I mentioned the debris, if we back off from the chemicals for a moment, as generated inside the annulus and then is swept down the stairways, and then probably settles at that point, sits for 20 minutes, and then when I turn the pumps on in recirculation --

CHAIRMAN WALLIS: It may or may not move.

MR. PETERSON: -- it meanders toward the screen, predominantly near the floor. So the fact that we are introducing it up high is only helping on getting some of --

CHAIRMAN WALLIS: More conservative than putting it on the floor.

MR. PETERSON: -- putting it all on the floor and trying to get it to jump up. You know, gravity is still going to be out there, and --

CHAIRMAN WALLIS: Did you try sort of using different people with different buckets to see how much scatter there was in the results?

MR. PETERSON: I think they are all Swiss. Right?

CHAIRMAN WALLIS: No, it's not a trivial thing, and you know, it would be interesting to see how much variability you could get by how you put the stuff in. They would all be conservative, but it would still be interesting.

DR. BLUMER: What we actually --

VICE CHAIRMAN BANERJEE: Are they uniformly distributed?

MR. PETERSON: We have done repeat tests.

DR. BLUMER: They are not uniformly distributed. You will see a picture later on.

CHAIRMAN WALLIS: More at the bottom than the top, of course.

DR. BLUMER: Definitely. That's why we don't get the same bed as well.

CHAIRMAN WALLIS: Well, if you put it in very close to the top, you might get it all at the top. If you trickled it down --

DR. BLUMER: Well, that is what happens when you introduce the debris. You have a higher density of the fluid, and it goes to the bottom and forms a sort of a vortex; and when you see what is happening, also the modules before get dark very quickly. First, of course, you have clear water, and the whole thing really moves around.

CHAIRMAN WALLIS: So the plume from the bucket depends on the velocity of the fall from the bucket.

DR. BLUMER: But I don't think the bucket introduction method is very important, because you've got a fairly quick distribution in the whole thing. But the most conservative we can do is put it in front of the strainer.

If we stuff it manually into each pocket, that's also not reasonable. It's not realistic. So we must put it as close as possible --

CHAIRMAN WALLIS: As long as, I suppose, you have a big margin, it's all right. But if you came to the point where you were --

DR. BLUMER: Well, we'll talk about --

CHAIRMAN WALLIS: -- then you might be able to fiddle the results by manipulating the bucket appropriately. You might be able to vary them by a factor of two, let's say.

VICE CHAIRMAN BANERJEE: In this case, there's so much area, it's probably not an issue.

CHAIRMAN WALLIS: Maybe it's not an issue.

MR. PETERSON: Maybe one way to answer, we have done repeat tests. Now I don't know how -- You know, I assume it was introduced the same way, but the repeats came out relatively close to each other for the debris loads.

CHAIRMAN WALLIS: Well, you didn't have someone trying to get different results by putting it in differently?

MR. PETERSON: No. These were meant to be repeats.

CHAIRMAN WALLIS: I think you ought to

talk to NRC staff and say see what you can do with the bucket, see if you can make it different, because this is the number you are going to use for design, isn't it? They wont' be too sensitive to the experiment.

MR. PETERSON: And, you know, as we have described, we feel there is conservatism on most steps as you work your way through it.

CHAIRMAN WALLIS: That may be true, but then you could have easily got four instead of two or one instead of two.

MR. MATHUR: But if we introduce a different precipitate --

MR. PETERSON: That's the other thing.

MR. MATHUR: It was not just one time we introduced it.

MR. PETERSON: It's staged. When we did these, we -- First, you don't know the answer. Second, as I mentioned in my statement that you are doing these debris calculations simultaneously with testing. The hope is that you test something that works that you can support by analysis.

So we did these as introductions. We did 40 percent, 70 percent of the final debris load.

CHAIRMAN WALLIS: Right. You put it in different batches.

MR. PETERSON: So it's at least different buckets.

CHAIRMAN WALLIS: You put it either all in one bucket or in a whole series of buckets?

MR. PETERSON: It's a whole series of buckets.

CHAIRMAN WALLIS: Right. All those things make a difference.

DR. BLUMER: The chemicals were tested up to 140 percent. So --

CHAIRMAN WALLIS: Okay. Maybe we should go on. We've talked enough about it.

DR. BLUMER: Well, the next slide shows you what was asked in an earlier question about the form of the bucket, and you see that there is one entrance of the water and actually five sides where the water flows out again. So that's the basic principle of our strainers, and we have used that principle for BWR strainers as well as PWR strainers.

CHAIRMAN WALLIS: I think we need to let the recorder have a short moment. Is that right? So we are going to have to take a break. How long is this break going to be? Five minutes?

We'll let's take a break until, let's say, 25 to six. Would that be okay? You want to take a more substantial break? We could take a break until 20 minutes to six then, and then we'll come back refreshed, and we can ask more questions.

(Whereupon, the foregoing matter went off the record at 5:31 p.m. and went back on the record at 5:43 p.m.)

CHAIRMAN WALLIS: Let's come back into session and continue where we left off.

MR. LEHNING: May the staff just make a comment on the debris at this time?

CHAIRMAN WALLIS: Absolutely.

MR. LEHNING: We were looking -- I guess we heard the different comments based on the debris addition and for what purpose it is and uniformity. Our position is that we expect a conservative approach and not necessarily analyzing small perturbations to that, as long as the licensees do a conservative job, and for the purpose of maximizing the head loss, for the tests that we have observed we felt that adding this debris near the front of the strainers was conservative in the sense of generating a uniform debris bed.

There are a few pictures in here of the debris bed. It's a little bit hard to see it for this case, but the mixing and dispersion of adding that debris to the test tank was often greater than the flow going into the pockets and --

CHAIRMAN WALLIS: It's conservative with respect to what happens in the plant?

MR. LEHNING: That is what we would expect.

CHAIRMAN WALLIS: it may be conservative by a factor of 10.

MR. LEHNING: In addition to the other points as they already raised, the non-uniformity in the vertical profile and the actual plant.

So that was our staff view.

CHAIRMAN WALLIS: Okay.

MR. LU: I just want to add one more point there. Since you also mentioned it as non-conservative, the variation might be acceptable. I just want to point out what might be the conservative here.

They are conducting tests assuming all the debris, including the eroded fiber. They end up on the screen surface right out of the recirc time. That's an additional conservative. And the internals of the corroded aluminum and then the chemical effects is less than -- the corrosion were less upon several days, hours. It generated that much. It would take several days. Then they assume it's 100 percent --

CHAIRMAN WALLIS: So this is conservative from the point of view of pressure loss.

MR. LU: So, yes. We asked them these questions about testing protocols. We can delve into many, many different variations which can trigger the question what's the uncertainty, but if we consider the input, the debris inputted to the head loss testing, actually it covers not only CCI but also for the entire fleet, and then the other inputs are conservative.

So should we delve into that much detail regarding the variation and the uncertainty there? I think the staff took a stab, and we believe that is reasonably --

CHAIRMAN WALLIS: It may well be conservative from the point of view of head loss, but from the point of view of bypass, it may go the other way. Putting on the uniform debris may be not conservative from the point of view of what gets through.

MR. LU: We have somebody else here.

CHAIRMAN WALLIS: Okay.

DR. BLUMER: Okay. Well, again this slide shows you the typical pocket, as we have used it everywhere.

The next slide, you see some results. The filter surface is given the approach velocity --

CHAIRMAN WALLIS: This velocity is flow rate divided by the total area of the strainer pockets?

DR. BLUMER: Right. Right.

CHAIRMAN WALLIS: Runs off the facial area?

DR. BLUMER: No, no. And then --

VICE CHAIRMAN BANERJEE: How about if you use the facial area for velocity?

DR. BLUMER: But for what purpose?

CHAIRMAN WALLIS: Transporting debris to it.

DR. BLUMER: For that, you surely have to use the approach velocity to the strainer and not the filter screen velocity.

VICE CHAIRMAN BANERJEE: No. I meant what is the approach velocity to the face approach?

DR. BLUMER: I think it's about a factor of 12 or 14 higher, probably more on the order of magnitude.

VICE CHAIRMAN BANERJEE: So in the experiment you did, the approach -- the face of the strainer was not this velocity. This is the approach velocity to the filter area.

DR. BLUMER: Right. Right. So multiply that by 12 or 14 or a bit more. I don't know for Salem exactly the factor between the approach surface and the filter surface, but it is about 12 or 14 or something.

VICE CHAIRMAN BANERJEE: So your actual velocity was like .04 or .05.

DR. BLUMER: Just take away one zero after the comma -- after the period.

The pH value is typical. Maybe somebody else can comment about this. The theoretical debris bed thickness is 1.6 inches, which is theoretical, because you get some overlap within the pocket, of course. The fiber to particulate ratio, which is one over eta, is 0.74. Then the water turnovers per hour, depending on the loop volume, was 6.3 for the high flow velocity and 3.6 for the one-pump operation.

VICE CHAIRMAN BANERJEE: It went round 6.3 times?

DR. BLUMER: Per hour, yes. There you see the debris that we have used and the chemical that was used as well, the sodium aluminate and the sodium silicate.

So the next graph shows you what happened. We did some testing, and then we also decided at Christmas we want to let the test run until after the long holidays there in Switzerland, and we had a 12-day test.

The head loss went up almost linearly over these whole 12 days. We made two fits there, but if you look at the whole range, we have steady increase from about one foot of head loss up to two feet of head loss.

CHAIRMAN WALLIS: And it's still going on. It's still going on.

DR. BLUMER: Yes, right.

CHAIRMAN WALLIS: But you haven't changed any chemicals or anything?

DR. BLUMER: We dumped in all the chemicals at zero hours and all the debris. The only thing we did before, a test at 9,000 gallons per minute, and then we reduced it to 5,110 for this test that you see here.

CHAIRMAN WALLIS: Why is it going up for 12 days?

DR. BLUMER: Well, we can have two reasons. One is we had some settlement of debris before, and there is a certain erosion of the settled precipitates that is occurring, or that there is certain aging of the chemicals, of the precipitates that is occurring in the loop are the things I can imagine.

That is what was measured, and we decided to extrapolate this linear relationship up to 30 days, and that is what you will see --

CHAIRMAN WALLIS: What happens in the sump in the plant? Does this go up like this? When does it stop?

MR. PETERSON: The part that was -- We had a stability criteria that was very tight. We were meeting our stability criteria during this time. It was a unique time frame for us, because we had this holiday area.

I was at a previous public meeting, and there were some concerns expressed by the staff to, I believe, some tests at Argonne that had been run a period of time. So we chose to run this.

We have, as Dr. Blumer mentioned, a few theories, but we penalized ourselves with -- you know, extrapolated to 30 days and penalized ourselves with it right now.

CHAIRMAN WALLIS: You are going to be going beyond 30 days or you just stop at 30 days?

MR. PETERSON: As was mentioned earlier today, there's quite a few things you can start doing long term. You can start doing your emergency operating procedure. People have used 30 days as a mission time for this.

MEMBER ABDEL-KHALIK: This debris thickness that you refer to as being 1.6 inches -- when was that measured?

DR. BLUMER: Well, that's just a calculation.

MEMBER ABDEL-KHALIK: It's a calculated value responding to all the debris --

DR. BLUMER: You just take the volume of the debris and divide it by the theoretical surface.

MEMBER ABDEL-KHALIK: Assuming what --

DR. BLUMER: Three thousand feet, the spread-out surface.

MEMBER ABDEL-KHALIK: Yes, but you know, is it solid or assuming some kind of packed bed of particles?

DR. BLUMER: No. It's the as-fabricated density that we use of the fibers, and that gives us a certain volume, and actually it is specified as a volume.

MEMBER ABDEL-KHALIK: Would be compacted?

DR. BLUMER: I don't think so at these head losses there is a big compacting going on.

MR. PETERSON: Well, a couple of things. First, it's a calculation, same as when people used to refer to an eighth of an inch as a thin bed; and second, in these pockets it is not a true thickness, something you can go in and measure. You know, you have pockets --

CHAIRMAN WALLIS: It's a big fraction of the pocket volume, isn't it?

MR. PETERSON: It's just a characterization of the --

CHAIRMAN WALLIS: But the width of the pocket is how much?

DR. BLUMER: Well, if you look at the next slide -- maybe you can show the next slide. You see that the pockets are pretty full. Yes. In the middle picture that you see there, you see that there is not much free space. So if you have it spread out as screen, a theoretical one, you get 1.6 inches, but here, of course, you get overlap between the surfaces, and they interfere. So that you don't have a full -- not a filling of the pockets, but still quite a substantial using up of the interstitial space.

VICE CHAIRMAN BANERJEE: How long do your normal experiments last?

DR. BLUMER: Until we reach termination criteria.

VICE CHAIRMAN BANERJEE: Which is typically when in terms of hours?

DR. BLUMER: Well, we've done testing between a day of, say, eight hours or two days, typically.

VICE CHAIRMAN BANERJEE: So 48 hours?

DR. BLUMER: Right, yes.

VICE CHAIRMAN BANERJEE: So how here you have a condition which is a head loss of one foot in 48 hours. What's the variability on that, if you repeated these tests, typically?

MR. PETERSON: We didn't repeat the long term tests. The other tests we repeated, and within a few tenths of a foot.

VICE CHAIRMAN BANERJEE: So here is one foot. Right?

MR. PETERSON: Right.

VICE CHAIRMAN BANERJEE: Will you get -- I looked at your data or you showed it to me. How variable is that going to be at one foot at 48 hours?

DR. BLUMER: Well, it depends also the way you are doing the testing. What is not shown here is the history up to 48 hours. We had a flow rate of 9,000, which we reduced to 5,110 afterwards. So we get some pre-compaction of the whole debris layer, which we thought was conservative for this flow rate.

VICE CHAIRMAN BANERJEE: So if you repeat it whichever way you like -- I'm just trying to get a handle on the variability. Is it that, if you repeated this test for 48 hours, you would get 1 1/2 feet sometimes, .5 feet sometimes?

DR. BLUMER: Well, we have not repeated this test, but we can say from other tests, for example, for another U.S. plant, we had very good repeatability for the chemical tests. There we repeated the test, and we had very similar values.

MR. PETERSON: Let me try to answer that. As far as on the debris portion of it, we have repeated it, and I believe the repeatability was on the order of -- the variation, a tenth of a foot. It's pretty close.

VICE CHAIRMAN BANERJEE: On how many feet?

MR. PETERSON: It would be something less than a foot.

VICE CHAIRMAN BANERJEE: Well, with chemicals you are getting one foot loss at these velocities. Right?

MR. PETERSON: Correct.

VICE CHAIRMAN BANERJEE: So without chemicals you must get a lot less.

CHAIRMAN WALLIS: Yes. What do you get without chemicals?

MR. PETERSON: Regrettably, we probably could have had 300 slides. We deleted so many of them.

CHAIRMAN WALLIS: What do you get without chemicals?

MR. PETERSON: I just don't recall.

CHAIRMAN WALLIS: Is it much less or is it half or something? Is there a very big effect here?

VICE CHAIRMAN BANERJEE: Well, everywhere else it seems to have a huge effect.

CHAIRMAN WALLIS: Three orders of magnitude.

VICE CHAIRMAN BANERJEE: Three orders, two orders of magnitude.

MR. PETERSON: That was not -- We did not see anything like that. I think the way a number of people have characterized this is, as long as you still have some open area, then the chemicals aren't so bad. If you close the area, then you see these orders of magnitude.

CHAIRMAN WALLIS: But the pockets -- whether you actually fill up every pocket. If you don't fill up a pocket, then there is no chemical effect for that pocket. There's no fibers in it. It makes a difference how you distribute the fibers among the pockets.

MR. PETERSON: The center slide here -- I mean, this is after drain-down, because there is no way to really get inside.

MR. SCOTT: Can I make a point here, please? I think it's important to remember that the objective for the testing that the licensees are doing is simply to show that they are adequate conservative. So they've made the point here that dumping it in at the top is conservative, and I think for the same effect that mentioned, it is also conservative as well, Dr. Wallis.

So as long as they can show that it is conservative, then the variabilities in, for example, the bucket loading that you were talking about, I don't believe, are going to going to come into play, unless I misunderstand your concern.

CHAIRMAN WALLIS: Well, sometimes it's not so easy to know just what is conservative.

MR. SCOTT: Okay. Well, I just wanted to

make -- I understand, but I wanted to make the point that these licensees are testing to show that they are conservative, and when they get to that point, they consider themselves complete.

MEMBER ABDEL-KHALIK: Well, how do they know that linear extrapolation of this plot over a few days, up to 30 days, is conservative?

MR. SCOTT: That's a separate question. I was referring to the loading that he was talking about.

MEMBER ABDEL-KHALIK: But, you know, without understanding the mechanism for the increase in pressure over this multi-day period.

MR. PETERSON: The thought process was we ran roughly a third of our 30-day mission, and it was quite linear during that whole time.

MEMBER ABDEL-KHALIK: But what is the cause of the pressure increase during that period?

DR. BLUMER: We have mentioned two things, that I can imagine some erosion of the stuff that is lying next to the strainers, as you see it in this graph on the lefthand side. You see some deposition at the lowest rows. And that there may be some erosion occurring just similar to the erosion of the fibers that have been tested before.

The second thing could be an aging of the chemicals.

MEMBER ABDEL-KHALIK: Well, how about a change in the morphology of the bed?

MR. BUTLER: That's the point I was going to make. You are starting with your 30-day loading of chemicals and debris. At that day one, you are starting with 30-day loading. You've already got a bed there. There may be over time a changing of flow, a compression, further compression of that bed over time, but you've got to view that in part as day 31, day 32.

MR. PETERSON: And to clarify, we are using 140 percent of the chemical load, which the hope is when the subsequent WCAP comes out from Westinghouse with the inhibition and things like that -- We have not credited any of that, but that analytically we could go back and possibly credit some of that. We got to look into it. Then it might be, rather than a 40 percent chemical margin, substantially higher, much like how we did the debris load where we have the test results and then somewhat fit the analysis, you know, to justify that load. But at the present, it's got a 40 percent margin, plus as John just said, it's the whole 30-day at time zero.

MEMBER ABDEL-KHALIK: Thank you.

VICE CHAIRMAN BANERJEE: What is the end result of the chemicals?

DR. BLUMER: I have the results on the PC. Can I go on with this in the meantime?

CHAIRMAN WALLIS: Please.

DR. BLUMER: Okay. On these figures you see on the left side, there is some sedimentation. You also see some RMI that's lying there, and as I mentioned before, we didn't get much effect from the RMI, but you still see --

CHAIRMAN WALLIS: How much of the material is sedimented here? What fraction? Do you have an idea?

DR. BLUMER: It was measured, but --

CHAIRMAN WALLIS: Looks like a fair amount of stuff down there, like quite a lot of material sedimented.

DR. BLUMER: And on the righthand side you see a look into the loop after removal of the specimen.

CHAIRMAN WALLIS: So there is material deposited all the way along the loop, or no? Not a long way along. It's clean beyond. We are looking upstream in the loop on the righthand side?

DR. BLUMER: Yes.

MEMBER ABDEL-KHALIK: So when you correlate the pressure drop data, you correlate it in terms of the total amount that was placed in the loop or the total amount minus the amount that was deposited upstream of the filters?

DR. BLUMER: We decided that this is the most realistic way we can do the testing, and sedimentation is part of reality here. We cannot do experimenting in space, and it couldn't be realistic. So we have to have the gravity effect within the testing, and --

MEMBER ABDEL-KHALIK: But this is true only if you expect sedimentation in your experiment to be identical or similar to what you expect in the real system.

MS. PENROSE: Well, don't forget the materials added immediately upstream of the strainers, and in reality it is considerably further upstream. So if you see a wedge shape here, you would expect to see a wedge shaped deposit in the prototypical.

MR. PETERSON: The screen velocity -- not using the terminology of an approach, but the velocity near the screen is scaled the same as in the plant. So we have a flow rate, if it's a two-train scenario, 9,000 gpm, and we have ratioed that based on the number of modules. So we have the same flow rate approaching the screen.

So if settling occurs because we drop it directly in front of the screen, it would happen in the plant, and it would be swept along the floor. There is nothing different that we are doing here. We are doing it at the same flow rate as would be experienced in the plant.

MEMBER ABDEL-KHALIK: The particle number density upstream of the filter during your experiment is the same as what you would expect in the plant?

MS. PENROSE: The mass load on the screen is the same.

MR. PETERSON; Yes. It's ratioed by the area, by the number -- by the pocket area.

MEMBER ABDEL-KHALIK: But in terms of particle density, number of particles would be the same?

DR. BLUMER: Yes. That's the scaling load that we use all the time. So flow rate and surface and debris quantities are scaled by the same number.

MEMBER ABDEL-KHALIK: Okay. And therefore, that's the basis for saying that you would expect that the amount of material settling upstream of the filter would be in this case much smaller than what you would expect in the real plant; because the transit time --

DR. BLUMER: In the real plant, it will be much better, because the water has to flow over the strainer to the other side.

MEMBER ABDEL-KHALIK: For a much longer distance.

MR. PETERSON: Yes.

DR. BLUMER: And you get this curb effect in the plant, because the water flows predominantly over to the other side, and we didn't model that. We just modeled the approach from one side. So if you take this effect into account that the water actually to the other side has to flow over a very high entrance, then it's much better in reality.

CHAIRMAN WALLIS: So the decision here all depends on the judgment of the staff that you have been conservative enough.

VICE CHAIRMAN BANERJEE: Well, I'm not convinced that you have been, because if you look at the flow velocities approaching, which is what we are talking about, they lie in the range of half a foot per second to .7 feet per second, your own calculations. That's what the flow velocities are.

You are using velocities which are a fraction of that.

If you look at your slide 25 and assume that those are flow velocities, because they are one to three inches above the floor, then you've got velocities which lie in the range of .45 to .63 feet per second, which is almost two orders of magnitude higher than what you are showing there.

MR. PETERSON: Correct, but those are quite distant as you work around this large accumulator, around a stairwell.

VICE CHAIRMAN BANERJEE: Well, this is actually leading up. So the fact that the debris won't be transported to these is a specious argument. I think, if you wanted to emulate this, you would have the turbulence conditions which are typical of this. You would have had approach velocities which were lying between .5 and .7 feet per second.

So I don't believe that you have answered Graham's question. In fact, I don't believe it's a conservative argument that you have put forward.

MR. PETERSON: One thing, as I mentioned when I showed the CFD and the reason it is stated as preliminary and needs to be rerun with the trash pack.

VICE CHAIRMAN BANERJEE: Well, that's

fine. I'm just going on this. When somebody got up and said that they believed it was conservative or maybe they didn't -- I don't know -- but I think Professor Wallis' point is that it matters how you dump this stuff in, because I think it's a lot more turbulent in the real situation than you are talking about.

If you believe these numbers, it's a lot more turbulent.

MR. PETERSON: So again in the real scenario in the plant, we would generate the debris inside the annulus, would --

VICE CHAIRMAN BANERJEE: We are talking two orders of magnitude lower than this.

CHAIRMAN WALLIS: Actually, you wait. You put it, and then you leave it there before you turn on the pump.

MR. PETERSON: Right. I wait 20 minutes. I let it settle down to the floor --

VICE CHAIRMAN BANERJEE: You increase the velocity to half a foot per second. It's quite a high velocity. The Reynolds numbers here must be of the order of hundreds of thousands foot per second. It's a very turbulent floor.

MR. PETERSON: When you go through those

restricted areas. Correct, and then they hit other areas.

VICE CHAIRMAN BANERJEE: I'm just saying that I'm not -- and I think Graham is not convinced that dumping it the way you did it, a quiescent fluid, is actually typical of what is happening.

MR. PETERSON: Well, quiescent -- I mean, when we dump it in, the pumps are running.

VICE CHAIRMAN BANERJEE: They are running, and your approach velocity is .02 feet per second. Here it is .5 on the ground. On the ground.

MR. PETERSON: I see in front of it the dark blue.

VICE CHAIRMAN BANERJEE: Yes. Look at the yellow stuff.

MR. PETERSON; I see down to something less than .09.

VICE CHAIRMAN BANERJEE: No, no, no, no. Look at the velocities approaching -- We are talking of entrainment of this material into the floor. This is the velocity near the floor, one to three inches from the flow, one to three inches from the floor that you have shown.

MR. PETERSON: Correct.

VICE CHAIRMAN BANERJEE: Okay? These

velocities in the yellow and green regions which are screening the debris --

MR. PETERSON: They are nowhere near the screen, though.

VICE CHAIRMAN BANERJEE: Doesn't matter, near the screen. I'm saying whether it's turbulent enough to entrain the material.

MR. PETERSON: Yes.

VICE CHAIRMAN BANERJEE: And what's happening is you are dumping this stuff into quiet water. Here it will all sink, naturally.

MR. PETERSON: No, no. The water is not quiet, though.

VICE CHAIRMAN BANERJEE: It's moving at .02 feet per second. If that's not quiet water, what is quiet?

MR. PETERSON: Oh, I don't have that.

VICE CHAIRMAN BANERJEE: Look, it's in here. I really don't want to get into this, but I just object to the fact that it is called conservative. If you look at Slide 60, multiply those numbers by 10 to get the FIS, it's .04 and .02, and your numbers there are .5 and .7. Okay? So whatever is entraining the stuff -- I mean, if you just look at the Reynolds numbers, you are a factor of at least 10 to 100 off on the Reynolds numbers.

CHAIRMAN WALLIS: So we have something that has to be resolved next time we meet perhaps?

VICE CHAIRMAN BANERJEE: I think so. Turbulence is important. It's sort of important in most things.

CHAIRMAN WALLIS: It doesn't die away right away. I mean, if you have the jets with turbulence at one end of this annulus space, that is going to continue.

VICE CHAIRMAN BANERJEE: Maybe you have another argument why it is not turbulent.

MR. LU: I'm just adding one observation here. They are talking about the circumferential velocity. If you are comparing a screen approach velocity versus that CFD analysis, you are absolutely right.

I think that we are supposed -- For this particular case we are supposed to compare the circumferential velocity, so which is several factors higher than the approach velocity.

CHAIRMAN WALLIS: You can do a test. During analysis you fill the sump with water, and you turn on the recirculation pumps, and you see what happens.

MR. LU: It's a full scale analysis and test.

VICE CHAIRMAN BANERJEE: I am simply objecting to this being called conservative.

CHAIRMAN WALLIS: Well, if it's not conservative, then what are they going to hang their hat on?

MR. LEHNING: This is John Lehning of NRR staff. We identified the same question. We had a conversation with Salem and vendors over the phone and asked this similar question on the turbulence and other effects based on this test. So just so you know.

CHAIRMAN WALLIS: I think the staff is asking all the questions we are asking, and they are the ones who have to sign whether it's okay.

MEMBER ABDEL-KHALIK: Is there any way to estimate from the data how much of the material has actually settled?

MR. PETERSON: Yes.

MEMBER ABDEL-KHALIK: Or is it too late?

MR. PETERSON: No. There's observations that are recorded during the test of how much. You know, they have run test after test. There's an observation of how much.

CHAIRMAN WALLIS: Well, I think next time we meet with the Commission, we will nominate Sanjoy to be the spokesperson.

MEMBER KRESS: That's an idea. His time has come. But it's not just the staff.

CHAIRMAN WALLIS: Okay. I think we should move on. This is something for further discussion.

MEMBER ABDEL-KHALIK: If I could go back to the question I was asking, do you recall how much of the material has actually precipitated upstream? Is it 10 percent or 50 percent or 90 percent?

DR. BLUMER: I must get back to the testing people to find out. I will tell you right away. I don't know the number by heart.

MEMBER ABDEL-KHALIK: Thank you.

CHAIRMAN WALLIS: It would also be good to have photographs of all of the pockets, not just the bottom rows, to see how much material is in the top row.

DR. BLUMER: We have additional photographs, of course.

CHAIRMAN WALLIS: Interesting to see how much material is in the very top row of pockets where you put the bucket in, whether you get much in there at all, because you could have a bypass of four pockets at the top.

Okay. Are we ready to move any further on?

DR. BLUMER: Okay. Next slide, please, next one. Next one. Okay.

Well, again the head loss increased from one to two feet in 13 days or 12 days, however you count it, and the head loss was --

CHAIRMAN WALLIS: That second one, I marked that as being interesting, because in fact, presumably, it's the ones on the very top that have the least material in them.

DR. BLUMER: Right.

CHAIRMAN WALLIS: And so perhaps that is how you managed to avoid a higher head loss, by having not much material on the very top. So it would be interesting to know how much there is there.

DR. BLUMER: And we still have an increase. It was almost linear over the whole time, as I said before, and adding RMI didn't affect the head loss very much. Of course, we also got some settling there.

Then the reduction of the flow from 0.0046 to the one-pump operation reduced the flow rate, not in a proportional manner but more than that. Then we increased it again, and we had an increase from 2 to only 2.5 feet, getting back there.

MEMBER KRESS: Were those two different tests or during the same test?

DR. BLUMER: Well, if you look at the --

MEMBER KRESS: Yes. I was looking for the reduction first, from 2.6 to one foot.

CHAIRMAN WALLIS: It doesn't seem to be on the figure, does it?

MEMBER KRESS: No.

DR. BLUMER: So you see on the graph that we had measured head loss up to 2.5 feet.

CHAIRMAN WALLIS: Oh, this was at the beginning.

DR. BLUMER: No.

MEMBER KRESS: No, at the end.

CHAIRMAN WALLIS: No, but this reduction of 2.6 to 1, was that at the very beginning?

MEMBER KRESS: Yes, that's what I was thinking.

DR. BLUMER: No. I think --

CHAIRMAN WALLIS: You see, the experiment was --

DR. BLUMER: It was at the beginning, right.

CHAIRMAN WALLIS: This is the beginning.

DR. BLUMER: Right. That was at the beginning at 48 hours.

CHAIRMAN WALLIS: That's at the beginning.

DR. BLUMER: And the other one is at the end, and so we were back to 2.5, which was not proportional to the flow rate.

CHAIRMAN WALLIS: Now we are a subcommittee, and we are going to have a meeting of the full committee in July at which this is going to be presented. It seems to me personally we are going to come around to this again, but the most interesting part of all of this is the particular test which is going to be used for the plant design, which is what we are talking about now.

That's the most interesting part of everything we have heard so far. This is what should be presented to the full committee. Is it planned that you folks will be there for that meeting? Is that the idea?

MS. ABDULLAHI: I don't think we've planned the agenda yet.

CHAIRMAN WALLIS: Because I think the last thing we want to hear is there's all the work in process, and nothing has been finished, which is what we heard this morning. But this sort of stuff is -- You're going to hang you hat on this for design purposes. I think the committee would be really interested in that.

VICE CHAIRMAN BANERJEE: We like to see data, and the only aspect of this which is a little unsettling is what is the uncertainty in this slope. In other words, if you had, say, even more data at 48 hours and that showed what the uncertainty was, is it 48 hours 1.5 or 2 or .5, some measure of this.

DR. BLUMER: You mean to say, if you did more than one test?

VICE CHAIRMAN BANERJEE: Well, if you had even other tests which ran out for a period --

MR. PETERSON: As I mentioned earlier, without the chemical test with the debris, which makes up a bigger chunk of the total, we have done repeat tests.

VICE CHAIRMAN BANERJEE: Right.

MR. PETERSON: We have all that data. There was a slide earlier of the number of tests that had been done specifically for Salem. There have been numerous head loss tests, including for the design basis like fiber load and, you know, Min-K load. With the predominant actors, we've done repeats. Those came out relatively close.

VICE CHAIRMAN BANERJEE: I think that would be in itself valuable to have, because without the chemicals, clearly, it's interesting to know what the uncertainties are.

CHAIRMAN WALLIS: Well, we want to see data, but we also particularly want to know the basis for the staff's decision, and the basis for the staff's decision, to my understanding, is these type tests. You are going to use these tests to validate the design in the plant.

Really, apart from that, everything else is irrelevant. This is the key part of your decision making. That's what we should focus on.

MR. PETERSON: But one second. We may be able to give you --

DR. BLUMER: That was a repeat, but not for 12 days, of course.

MR. PETERSON: No, no. This is a data with 100 percent of the chemical. We didn't get the 140 in yet. Same debris load with a repeat. This is in millibars. One test was 76. The other one was 75.5.

CHAIRMAN WALLIS: They are about the same?

MR. PETERSON: Then we went up to the 140

-- the same test, but on each -- 77 and -8.

CHAIRMAN WALLIS: It didn't make that much difference.

MR. PETERSON: So those were repeats.

CHAIRMAN WALLIS: They were repeats.

MR. PETERSON: That's what I'm showing, that those were short durations.

VICE CHAIRMAN BANERJEE: How long were they?

MR. PETERSON: These were -- We would have to look. My guess is a few days.

CHAIRMAN WALLIS: So I think what we need to do is have sort of a set of criteria that the tests are demonstrably conservative, that they are repeatable, that they are this and this, and then you want to show it by evidence. That would be the argument to be presented to the full committee.

VICE CHAIRMAN BANERJEE: And I think the concern about the approach stream turbulence has to be dealt with in some way, because even though the flow is circumferential and not perpendicular to the bank, it still stirs it up. You understand the argument.

Here is the filter. The flow is going this way. Okay? And the approach velocity this way may be low, but the turbulence is generated by the flow going that way, and that is what is mixing up the stuff, and then that is being transported.

Now the flow going this way is at a very high Reynolds number. So it is very, very turbulent, even though the approach velocity sideways is rather small. You see?

So it would be like if you had, let's say, your box here, and it was sucking, but now you had a very fast flow going this way carrying the debris. It's fast enough that even right running from the bottom it is half a foot per second. So if you take a long velocity profile, it's of the order of two or three feet per second in the main stream.

CHAIRMAN WALLIS: It is a high Reynolds number, but it's -- It's just these pockets.

VICE CHAIRMAN BANERJEE: Unless your calculations are wrong.

MR. PETERSON: You are looking at an area remote. You are looking at the accumulators.

VICE CHAIRMAN BANERJEE: No, I am not looking at the accumulators. I'm looking at the circumferential velocity in front of the filters. If you look at your figure, that's what I was saying.

I'm assuming your calculations are right. I take no responsibility for them. But look in front of --

MR. PETERSON: We can do those confirmatories. They are easy enough calculations.

VICE CHAIRMAN BANERJEE: Yes, but as they stand right now --

MR. PETERSON: Yes?

VICE CHAIRMAN BANERJEE: -- look at this part of the flow. Look at your ten o'clock region. Right? Ten o'clock region there in front of your filters. Your velocities are yellow, green. Now they could be parallel to the filters. It doesn't matter if they parallel to the filters.

MR. PETERSON: They won't be, once -- Like I mentioned earlier, this is without the debris trash rack. The only purpose of these is currently --

VICE CHAIRMAN BANERJEE: It's okay.

MR. PETERSON: It is going to move you away from the screen farther.

CHAIRMAN WALLIS: But, look. They flow also past all these pillars. There is a wake from every pillar, and you can get into a --

VICE CHAIRMAN BANERJEE: Actually, I think the flow -- these types of flows with this height are very turbulent. It could be that the approach velocity going in is pretty low, because you have a high surface area. But the flow that is going by is very turbulent.

CHAIRMAN WALLIS: The Reynolds number is humongous.

VICE CHAIRMAN BANERJEE: It's humongous, and it is going to churn everything up. Honestly, believe me, I am not trying to --

MR. PETERSON: And our analysis has that in there right now.

VICE CHAIRMAN BANERJEE: It is very important that you have experiments or effect. That's why I said did you put some propellers or something to stir it up. I thought you were stirring it up. That's why I asked that question. Maybe there is no reason to stir it up, but in general --

CHAIRMAN WALLIS: Well, we are certainly stirring things up today, and I would like to move on, because I think we have made the point that there is an issue here.

VICE CHAIRMAN BANERJEE: Okay.

CHAIRMAN WALLIS: And the staff is scratching their heads about what they are going to do. So could we return to Slide 64 then?

DR. BLUMER: Okay. Now I'm talking finally about the overall head loss determination steps. We had this head loss which was a conservative value with regard to picking the flow rate.

We had two different flow rates, as you know, for one-pump and for two-pump operation; and we picked the one which had the higher relative value, and then we came up with a head loss as a function of time, of course, using these 12-day periods and extrapolated to 30 days, then as a function of temperature.

Because we tested only at room temperature, we had to use the viscosity to scale the head loss for other temperatures with the viscosity of the water. Then also the debris loading thickness, because as we have a long train here -- I'll come at that in the next slide. As we have a long train, we have an axial pressure gradient within these green channels, and we have a non-uniform flow rate into these modules as you go along in this long train.

We assumed that we have also a debris loading proportional to the flow rate into each individual module. So we came up with such a head loss function of these three parameters.

Then we made the final difference model computation. Maybe I will show it in the next slide. Yes, that is it. We have a pressure degree of freedom in each intersection between two modules. We have a inflow over the debris layer, and the axial flow was in the clean flow path, and we produced a finite difference scheme to calculate what's happening.

If we have higher head losses -- say, at low temperature where the viscosity is high -- and we've got a fairly uniform influx into the modules, typically 10 percent difference between the first module and the last one. But when we have very low debris head losses at high temperatures and early on in the first day, for example, then we get non-uniform debris influx into the modules, which can be a factor of two difference between the first and the last module.

So we used such a finite difference scheme to calculate that. Now we can go back to the other slide again, one before. Yes,

The second bullet was shown in this graph afterwards, and then we added the Z-shaped connection channel head loss, which we calculated by CFD, as you have seen before. The result is the graphs that we have as a function of time, temperature and flow rate. Now we can go two slides ahead. Yes, this one.

This is what we get for the 5,110 gpm. This is a one-pump operation. You see the temperature, and you see also the curves for a zero base. That is the beginning of the test for two days and for 30 days.

These numbers of time points were picked because they are interesting for the NPSH calculations. Then you also see the limit that was imposed. You see above the design temperature of 190 degrees that there is a small intersection of the curves, but actually it is not reasonable to have 190 degrees at 30 days. So this point at the intersection there is not really critical.

The next slide shows you that we have more margin with a 9,000 gpm flow rate. The graph shows you basically the same thing.

So you see that these two graphs show you that we have very large margins at lower temperatures, even after 30 days. The only critical time point is at the very high temperatures, above the design point of 190 degrees.

Of course, our chemicals have not formed all at these temperatures. So our head losses there seem to be fairly conservative. My overall conclusion on this is that we have substantial margins here.

MEMBER ABDEL-KHALIK: The temperature effect that you have included here is primarily a viscosity effect?

DR. BLUMER: Right. Yes, that's the viscosity effect. Yes.

MEMBER ABDEL-KHALIK: But the change in the source term itself, the amount of material?

MR. PETERSON: That was already included to come up with that 30-day integrated chemical value that we actually used 140 percent that we introduced at time zero.

MEMBER ABDEL-KHALIK: Oh, I see. So --

MR. PETERSON: So this is just the viscosity.

MEMBER ABDEL-KHALIK: -- that corresponds to the temperature of 190 degrees?

MR. PETERSON: The total loading corresponds to the 30-day integrated temperature. This temperature is just the viscosity change.

MEMBER KRESS: It's just the viscosity with water.

MR. PETERSON: Viscosity with water. We also put the chemicals in based on what was noted in ICET.

MEMBER KRESS: But they wouldn't affect the viscosity much.

MR. PETERSON: It was slight and we put it in. I think Dr. Blumer --

DR. BLUMER: Yes. I made an evaluation of the results of the ICET tests, and I took those viscosities and factored them into the results on the conservative side.

MEMBER KRESS: The delta is a linear function of what? You just extrapolated -- The pressure drop is linearly proportional to the viscosity?

DR. BLUMER: They are the portion of the debris, but of course, the turbulent part is assumed as constant and independent of temperature for this calculation. So you cannot scale it directly, if you look at these curves, because part of it is the clean head loss that was factored into this finite difference scheme.

CHAIRMAN WALLIS: I think we've got to the end here, haven't we? Have we got to the end? Then there is something called questions, isn't there, that haven't been asked yet. We can now leave the floor open for questions.

VICE CHAIRMAN BANERJEE: I noticed that you say some additional testing in the vendor's facility, supplemental testing at vendor's facility. So you could still conceivably stir up the stuff and see what difference it makes, especially with the chemicals. I think that would satisfy almost everybody in some way, if you stir it up. It may not matter if you actually stirred it up after that. Shouldn't matter that much.

CHAIRMAN WALLIS: It would be interesting to stir it up, try and get a uniform distribution.

VICE CHAIRMAN BANERJEE: You know, I was sure that you were stirring it up.

CHAIRMAN WALLIS: If you dumped as you stirred, you could dump it so that more of it fell to the bottom as you put it in. If you put it in further upstream and stirred it, you get a more uniform distribution on the screen, whichever way you want to do it. There's a lot of ways to change things.

DR. BLUMER: We've seen that through a quite bit of turbulence we reduce head loss enormously, because we disturbed the layer of debris on the screen. In some cases we dumped in RMI. The head loss went down, because we disrupted the layers.

VICE CHAIRMAN BANERJEE: See, I think what you've got in the real situation is that outside those pockets the external flow is pretty turbulent, as you would expect, because the Reynolds number is quite high.

Of course, once it goes into these pockets, it is not because your approach velocity is so low in these pockets in some way. As you correctly point out, it is very low. So what you are faced with is material which is fairly well stirred up outside, eat least for some part of the system, and it is sucking it into this reasonably well distributed.

That was why I asked you initially whether you stirred this before you introduced it, because I thought you were trying to emulate the system in the containment where the Reynolds numbers for the external flows would be expected to be quite high, not in the pocket itself. The local Reynolds number is very low there.

DR. BLUMER: Maybe we have to look at this more closely. But again, as you see in these curves, the margins that we have are --

VICE CHAIRMAN BANERJEE: May not matter at all. Sure. Sure.

MEMBER KRESS: Perhaps one approach might be if you had a pressure drop function as a function of the amount of debris on a unit area. I don't know if you have this anywhere or not, but one could develop a calculational tool that distributes it along the height different ways, and actually make an estimate of whether you get a different pressure drop for a uniform distribution or one that varies.

CHAIRMAN WALLIS: I think the problem with that is the chemical effects.

MEMBER KRESS: Well, yes, of course.

CHAIRMAN WALLIS: Because we don't know -- We have no way of predicting chemical effects.

MEMBER KRESS: I know, but that would be one approach.

CHAIRMAN WALLIS: That would be all right if you didn't have the chemical effects, I think.

VICE CHAIRMAN BANERJEE: They have a multi-node calculation which is one dimensional. If they made it two-dimensional, had a vertical --

MEMBER KRESS: Yes.

VICE CHAIRMAN BANERJEE: You could do it, exactly what they are saying.

MEMBER KRESS: But he's right. You don't know what to do about the chemical effect.

MEMBER ABDEL-KHALIK: Aside from all the questions that have been asked today, I would like to compliment you on, really, the amount of effort and systematic work that you have done on this issue.

CHAIRMAN WALLIS: And are you going to stay for tomorrow?

DR. BLUMER: I have a flight at six. So I'm not sure whether I can --

CHAIRMAN WALLIS: Now tomorrow we have another three cases. Each one of them is very interesting, and we will obviously go over the time.

VICE CHAIRMAN BANERJEE: I have a flight at 5:40.

CHAIRMAN WALLIS: Oh, so the last presentation is --

Okay. I think we ought to close it for today, unless someone has a burning desire. I don't see anyone leaping up and down, wishing to stay. So we will meet again tomorrow, same place, same time, 8:30 in the morning.

Thank you all very much.

(Whereupon, the foregoing matter went off the record at 6:37 p.m.)