Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
ABWR Subcommittee on STP COLA

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Tuesday, October 2, 2012

Work Order No.: NRC-1917 Pages 1-196

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

ABWR SUBCOMMITTEE ON STP COLA

+ + + + +

TUESDAY

OCTOBER 2, 2012

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Michael L. Corradini, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

MICHAEL L. CORRADINI, Chairman

J. SAM ARMIJO, Member

SANJOY BANERJEE, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

WILLIAM J. SHACK, Member

JOHN W. STETKAR, Member

ACRS CONSULTANTS PRESENT:

THOMAS S. KRESS

GRAHAM B. WALLIS

NRC STAFF PRESENT:

MAITRI BANERJEE, Designated Federal Official

A G E N D A

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN CORRADINI: Okay. The meeting will come to order. This is a meeting of the Advanced Boiling Water Reactor Subcommittee of the ACRS. My name is Mike Corradini. I am the new chairman of the Subcommittee, so treat me nice.

The ACRS members in attendance today are Charlie Brown, Sam Armijo, Dennis Bley, soon to be Sanjoy Banerjee, Bill Shack, John Stetkar and our consultant, Graham Wallis, and other consultants in the audience, I seem to understand.

Ms. Maitri Banerjee is the Designated Federal Official for this meeting. As announced in the Federal Register on September 28th of 2012, the subject of today's briefing is long-term core cooling, and that aspect relative to the COL application submitted by Nuclear Innovation North America or NINA, for South Texas Projects 3 and 4, and resolution of remaining issues from previous briefings on the subject.

The issue was discussed in various ABWR Subcommittee meetings in the last two years, and NINA and the NRC staff will provide a summary to refresh our memory. Kind of off script, just to remind everybody, we haven't talked about this in a year, and many of us haven't attended all five of the meetings. So I want to make sure that the staff and the Applicant have time to kind of refresh us on this.

The rules for participation in today's meeting were announced in the Federal Register notice for the open and closed meeting. Parts of this meeting may need to be closed to the public, to protect proprietary-related information. I'm asking the NRC staff and the Applicant to verify that only people with the required clearance and the need to know are present before we enter such a discussion.

So as we go through things, as we start a new subject, I'll just look to the Applicant and the staff to warn us, so that we can at least do a quick checkout. We have a telephone bridge line for the public and stakeholders to hear the deliberations. This line will not carry any signal from this end during the closed portion of the meeting.

Also, to minimize disturbances, the line will be kept in the listen-in only mode until the end of the meeting, when ten minutes are allocated for public comment. If we need more time, we'll give it if the public have comments.

At this time, any member of the public attending this meeting, or sorry. At that time, any member of the public attending the meeting in person or through the bridge line can make a statement.

As the meeting is being transcribed, I request that participants in this meeting use microphones located through this room when addressing Subcommittee participants would first identify themselves and speak with clarity and volume, sufficient clarity and volume, so that they can be readily heard. Also, please make sure your cell phones are turned off or muted.

We will now proceed with the meeting. I will call upon George Wunder of NRO to begin the discussion and kind of lead us off.

George.

MR. WUNDER: Good morning, Mr. Chairman, and thank you very much. Thank you for that very thorough introduction. I see you covered all the points that I had on my sheet and I have nothing to add, other than to say that it is our hope that by the end of the day, we have provided the Subcommittee with the information it needs in order to respond to the Commission's SRM. Thank you.

CHAIRMAN CORRADINI: I would say though again, I mentioned it once, but just to remind everybody. Since they're kind of going to what I'll call give us a refresher to kick this off, I'd ask that the Committee give everybody, let Applicant and staff kind of get us through the initial phase of this before we enter into the details, because I'm sure there will be details.

DR. WALLIS: If details appear on the slide, may we ask a question?

CHAIRMAN CORRADINI: You may, if it's clarification. No, I'm just joking. I think that we kind of pre-looked at the slides. I think their first ten or so slides is background. Then they're going to get into, I think, what some of the consultants and members are quite interested in.

So is Scott going to take -- George? Is that okay? I'm sorry, go ahead.

MR. HEAD: Thank you sir, and thank you for this opportunity to meet with you again. It has been over -- it's been over two years since our first meeting, and it's been literally a year since our last meeting on this topic. So we appreciate the opportunity to have this interaction today.

The point you were going to make or were making, one of the lessons learned we had from maybe the second or third meeting is we jumped right into closing follow-up actions, and we really didn't get a good review of where we were and the topic itself.

So our plan is today that I'm going to actually give a summary of everything we've done, both from a NINA perspective and our interaction with the staff and with ACRS. So I'm going to give that overview.

I'd like to get through it if I could, because I think it's important to have the big picture, because quite often we get into the details and I think it's important to understand the big picture of what a plant in our position has done with respect to this topic.

So that's how it's laid out. As you can see though, clearly we've brought our technical team here today to answer any questions that might still be there or new ones that might have evolved in the year since we have met. So we understand that that's an important part of where we are.

Here are the attendees that are with us today. I appreciate everyone joining us for this discussion. The agenda and quick introduction. I'm going to do the long-term fill in overview. I know they can raise some questions, but I would like to ask that if we can defer them to when we have a more appropriate point in the discussion, and some of them could be proprietary in nature.

Maybe the question's not, but we feel like the answer may be. So there's, you know, a place later on in our discussion to cover that. Then we're going to -- Jim's going to go through the summary of key points from our four previous meetings, and we feel like that will obviously be an opportunity to address any acts or any questions that the ACRS might have.

Now sensibly we're here simply to close Follow-Up Item No. 80. That's the only, that's the last one that's been opened, and we have not closed, and we're certainly prepared to do that today.

CHAIRMAN CORRADINI: And if I might just interject, since Scott brought it up from a numbers standpoint, everybody knows from Maitri's status for the members that this is a separate requirement from the Commission, and because, excuse me, because the certification had already gone through, the Commission's requirement for long-term cooling verification then applies to the Applicant and for the COL. So that's why we're taking it up now.

MR. HEAD: Yes, sir, which my next slide speaks to. This is the, you know, why we're here, and I would note that the staff requirements memorandum came out nine months or so after we made our application for STP 3 and 4.

We've done a lot of work, both you know, from an engineering perspective and a lot of work with respect to interactions with the staff and obviously with ACRS, to address the long-term cooling issue from a design basis perspective. So you know, you'll obviously see the results of that today.

In terms of an overview, the Advanced Boiling Water Reactor has a robust long-term cooling. There's numerous ECCS water sources for heat before it cools. Heat clad temperature during design basis LOCA is about half the limit. We have a very substantial ultimate heat sink, an adequate water supply for 30 days, as required. So that's the, you know, design basis aspect, if you will.

As part of the ABWR, as part of the work we've done, we've also addressed potential challenges to long-term cooling. You know, we've selected a strainer that will meet NPSH guidance, and it's a very large strainer, and it's based on a very conservative debris loading.

Let me back up. One of the things I forgot to mention is we're going to try to not introduce anything new in this discussion today. We've basically covered this all before, and you know, AC independent water addition, we've covered in other briefings.

But we felt at this point it's important in this one to note that it exists and it is a water source that is independent of the strainers. So it's something that we discussed in other, on other topics.

As part of, you know, as part of our effort, we've demonstrated that containment integrity is maintained, and due to the design features and the design process, ECCS gas accumulation will not be an issue, and I think one of the more important aspects and I think we've spent a lot of time on is the downstream fuel effects will be tested 18 months prior to operation.

And as we demonstrated in one of our meetings, that the long-term cooling will be met even with the fuel inlet blocked, and that's a defense indepth aspect that we've taken credit for.

CHAIRMAN CORRADINI: Okay, and Jim will go over these in more detail following your presentation.

MR. HEAD: Yes, sir. We'll --

CHAIRMAN CORRADINI: Okay, that's fine.

MR. HEAD: We're prepared to go, and so we have all the previous presentations with us today. So if there's an aspect of this we want to cover again, for example, that last item, we certainly can address that.

With respect to the downstream fuel test, the primary challenge of long-term cooling is does debris pass include the suction strainers and causing downstream effects on the fuel? There are a number of features that ensure downstream fuel effects are mitigated.

DR. WALLIS: Can I ask you about that? Is this your assessment, or is this the regulatory assessment? Is it your engineering assessment, that this is the primary challenge, or is this the regulatory assessment?

MR. HEAD: It's our assessment.

DR. WALLIS: It is your assessment?

MR. HEAD: Yes, sir, and I believe the staff --

(Simultaneous speaking.)

DR. WALLIS: And you're ready to back that up, that this is realistically the primary challenge?

MR. HEAD: Let me give my summary, and we'll --

DR. WALLIS: I just want to be clear, that it is your assessment?

MR. HEAD: Yes, sir.

DR. WALLIS: And if we ask you questions about it, you'll be prepared to --

CHAIRMAN CORRADINI: So Graham's setting you up, I'm sure you can see, because he's a very precise fellow. Can I ask this question a little differently?

All the other challenges have been solved, and this is the last remaining challenge, or has it always been the primary challenge?

MR. TOMKINS: Well, it's certainly the primary challenge from the point of view of we spent the most time on it.

CHAIRMAN CORRADINI: Okay.

MR. TOMKINS: With the NRC and --

CHAIRMAN CORRADINI: Good. That's a way of answering it. Let's just keep on --

DR. WALLIS: No. Years ago, it was not a challenge at all, and now it's --

MR. TOMKINS: Right, I agree, and now it is.

DR. WALLIS: And now it's become the primary. It's the remaining challenge. Maybe that would be --

MR. HEAD: If it's the remaining, it's the primary at this point.

(Laughter.)

CHAIRMAN CORRADINI: That's fair, that's fair.

MR. HEAD: It is the remaining challenge.

CHAIRMAN CORRADINI: Okay. Keep on going.

MR. HEAD: Okay. There are design features that help ensure downstream fuel effects are mitigated, are is that it's diverse water injection capability, the high pressure core flooder, you know, which comes in from above the core, and the AC independent water addition is also available.

We mentioned before we have state of the art suction strainers, as we'll talk about in more detail. We really don't take credit for those as part of the downstream effects, but they in fact are there.

I'll, you know, refer back to one of our previous meetings, when our engineering management and licensing were looking at this issue a couple of years ago.

Being from an operating plant, you know, we ask ourselves, you know, given where we are at this point in time, what decisions could we make now that would resolve what we believe many of the issues or many of the challenges with respect to the long-term cooling.

Or to put it in a different way, if we were an operating plant and you could say immediately what changes could I make right now and make some of the issues go away at an operating plant, what would we do?

That's been our philosophy as we've moved forward, and that's why it's easy to say there's no fiber, calcium silicate or aluminum primary containment. But those are significant decisions we made, to minimize the challenges that both from a fuel perspective and, quite frankly, from a licensing perspective, to address those.

So we've made those decisions, that there will be no fiber or calcium silicate insulation, which you know, is a significant decision. We also respect aluminum primary containment. There's also minimal zinc in primary containment, and that's only in qualified coatings. Also a significant decision that we made to address this issue, and --

MEMBER SHACK: Will all your zinc coatings have an epoxy top coat?

MR. HEAD: Yes, sir, and then, like I said, introduced in about the second or third meeting was the design fuel assembly bypass flow, which is a defense indepth feature that we believe it important to acknowledge it exists.

CHAIRMAN CORRADINI: But, and you're going to -- just to clarify, but you don't take credit for it in the analysis, if I remember correctly, in reading it?

MR. HEAD: Correct, and that's part of a licensing strategy, if you will, that we believe we can address the issue head-on, with the changes we've made and the testing we're proposing, and then still have this as defense indepth. We think it's important.

CHAIRMAN CORRADINI: Okay, thank you.

DR. WALLIS: Are you prepared to say what happens to the epoxy top coats --

MR. HEAD: Yes, sir, we are.

DR. WALLIS: Okay.

MR. HEAD: And then finally, there are strong programmatic controls over containment and suppression pool cleanliness, to ensure that latent debris amounts are low, and again, we looked at that from our perspective as an operating plant and the number of containment clean-ups that we've been involved with post-outage, closing up containment when you come out of an outage, and being aware of the controls that exist.

The oversight that's provided by the Nuclear Regulatory Commission as part of those containment closeouts, and in fact, you know, we have a corrective action program that identifies any issues, and you adjust your processes as you move forward.

We believe that's a very important part of the fact that latent debris will be low, as we -- when the plant is in operation. So we'll talk about in more detail the test programs but, you know, we believe we've done everything, will have done everything possible to ensure that latent debris are in fact very low.

There are a number of conservatisms in the downstream fuel test that we developed, because we thought it was important to be able to have lots of margin in this discussion, and we, and feel like that was important. You know, they related to the debris assumptions, the analysis of the acceptance criteria and the test performance.

The chemical amounts assume no solubility of zinc or aluminum corrosion products in the one million gallon suppression pool, and then all chemical products form gelatinous precipitants. We discussed that in a previous meeting, so we're not going to discuss this more today.

So we believe that's a, you know, very, very conservative assumption. We discussed the next one in a number of, in probably at least two meetings, that no credit for settling debris in locations where it will not impact the strainers and fuel, such as the lower drywell, the bottom of the suppression pool and the lower plenum.

You know, we make assumptions in terms of what is going to exist, and we assume it all gets to the fuel, which in fact is not really what's going to happen in these situations, but it's appropriate conservatism and will be part of the test.

DR. WALLIS: Are you going to tell us what to assume about the sludge and the rust and that sort of stuff?

MR. HEAD: Yes, sir.

DR. WALLIS: You're going to tell us?

MR. HEAD: What we can, yeah. Latent debris, latent fiber is all assumed to be 100 percent fiber fines with, as I mentioned before, 100 percent passing through the strainers. So the strainers in fact, with respect to the downstream impact, has no bearing.

Since fibrous material is prohibited, ~~axle~~ latent fiber in the plant is assumed to be rags and ropes because, you know, we've made these other commitments with respect to fibrous material, and that sort of debris will obviously be taken up by the strainers and won't get to the fuel.

DR. WALLIS: Is there any sawdust or anything like that that get in there?

MR. HEAD: Sawdust?

DR. WALLIS: Sawdust left over from some operation.

MR. TOMKINS: That would be a part of the containment cleanliness. I can't imagine --

DR. WALLIS: You'd have to keep it out.

MR. HEAD: Well, there would be two things that would happen. I will just, as we get into it --

(Simultaneous speaking.)

MR. HEAD: Okay. Now with respect to the analysis acceptance criteria, some very I think interesting and conservative assumptions we've made.

As decay heat is held constant at the value of five minutes after shutdown. This is long-term cooling, and we're challenging ourselves with a five minute heat load, and that's, I think, significant conservatism. It makes the analysis relatively easy, but it's not the actual challenge that we'll be seeing with respect not only to the fuel itself, but to the actual flow of debris.

The next bullet speaks to that. Debris particularly takes more than two hours to all reach the strainer the first time, and that is based on the actual suppression pool flow. It decayed about forty percent of value compared to the full five minutes.

And then, you know, an aspect of that with respect to long-term cooling is chemical precipitates such as zinc oxide, are predicted to take over 15 days to reach the values used in the test. So we instantaneously assume it all exists, and we relatively instantaneously assume it all gets there.

We challenge it with fuel that's going to stay at a heat level --

DR. WALLIS: How about those 15 days? It doesn't change its physical properties in any way?

MR. HEAD: We'll answer that one --

DR. WALLIS: Okay.

MR. HEAD: There's a factor of four margin of acceptance criteria, which is really a factor of two based on flow.

CHAIRMAN CORRADINI: What does that mean? I tried to look back in back documents, and I didn't -- can you just briefly clarify that? Or if you're going to do it later.

MR. HEAD: That's really, that's wrapped up in the follow-up item.

CHAIRMAN CORRADINI: Okay, fine.

MR. HEAD: So it'll be discussed --

DR. WALLIS: It's decay factor, isn't it?

MR. TOMKINS: Right. It's on Action Item 80.

MR. HEAD: Action Item 80, we'll cover all these details.

CHAIRMAN CORRADINI: Okay, okay. This will be explained. Thank you, thank you.

MR. HEAD: The void fraction of .95 in the hot assembly exit, which really is greater than twice the boiloff or flow rate, is another factor of two that's included in the acceptance criteria, and finally there's, as I mentioned before, the high pressure core flooder, no high pressure core flooder on fuel.

It's simply design bypass flow. It's credited, and each of those, by itself, is sufficient to provide adequate core cooling.

CHAIRMAN CORRADINI: And I wanted to ask there, I think I understand what that means. But again I'm new to this design discussion. Is that by calculation or by past testing, that the case is that each by itself is sufficient provide adequate cooling?

MR. HEAD: That's by calculation, and we'll be able to discuss that --

CHAIRMAN CORRADINI: Okay, later.

MR. HEAD: --in more detail.

MEMBER BROWN: When you say "each," what is meant by each? All the upper --

(Simultaneous speaking.)

MR. HEAD: No, just the two.

MEMBER BROWN: Just the HPCF ~~of~~ or the fuel assembly bypass?

MR. HEAD: Yes, those two.

MEMBER ARMIJO: Is there a reason why you don't credit the bypass flow?

MR. HEAD: Yes, sir.

MEMBER ARMIJO: It's a passive feature; you don't have to turn anything on or off. It's just going to happen.

MR. HEAD: Yes, sir.

MEMBER ARMIJO: Why don't you credit it?

MR. HEAD: Well, we -- as we embarked upon this journey and we're making the decisions that we made with respect to this issue, we felt like we had addressed the issue with changes to containment, the actual inherent design of the ABWR.

The programmatic processes that were placed that we've learned over the years. So we believe we could take this and address this issue, you know, head on, without relying on this feature.

In fact, this feature would then there be a defense in-depth. So we asked ourselves that. The staff asked us, why not maybe take this, you know, make this pivot, if you will.

We just felt that it was not, you know, that it's not consistent with what the industry is doing, and we felt like it would not be appropriate, given where we believe the advanced boiling water reactor is, and the attributes it has and the attributes that STP has bought to the design.

MEMBER ARMIJO: I can see your position

that it's not needed, but you know, if it's really a passive feature that's built in and that doesn't rely on any active systems to turn it on, turn it off, moderate it in any way, it seems excessive conservatism that --

MR. HEAD: Oh, it's there.

I mean it exists. It exists for really a separate reason. But it's there.

MEMBER ARMIJO: I understand, yeah.

MR. HEAD: And as a part of the licensing strategy, to be able to maybe answer that, or there's some question that there's some still unknown answer on, or some challenge that we felt that having this defense indepth would help us as part of the licensing process, and I'd say it was --

You know, that was our thought process, is that it would really be an inappropriate adjustment to what we believe was a very strong story.

DR. WALLIS: I was going over it, looking at your slides, and I'm wondering when is it I can ask detailed questions about this debris?

MR. HEAD: When Jim starts.

(Laughter.)

MR. HEAD: One more slide.

DR. WALLIS: Oh, only one more?

MR. HEAD: I think so, yes, sir.

CHAIRMAN CORRADINI: I told him to be polite to you, so he's --

MR. HEAD: It's incredible, sir. I appreciate it.

CHAIRMAN CORRADINI: He's ready.

(Simultaneous speaking.)

DR. WALLIS: I mean sometimes politeness is a veneer for something else. It's a very polite way of telling you things you don't want to know. It's the best way to do it.

MR. HEAD: I believe we want to know this, and I believe we're here to answer all questions that -- new questions or previously asked questions. So I've got no problem with that at all.

As I mentioned in my opening, though, I thought it was important to either overwhelm or bore you with everything that we've done on this project. So that's why I'm insisting on going through this.

Okay. With respect to the test performance, and we recognize some questions will come up with respect to this. But the debris is added in a manner that minimizes clumping, and it maximizes establishment of a filter bed and provides for the formation of the thin bed, all important aspects of a challenging test, and obviously Jim is here to address any questions that might come up with respect to that.

Okay, and then this speaks a little bit to, you know, something we were talking about earlier. The conservatisms in the ~~downfield~~ downstream test translate to what we believe is a factor of eight in flow margin, the fuel, the blocking of the fuel.

The five minute decay heat, you know, is twice the decay heat expected, once the actual debris is deposited. As I mentioned before, the acceptance criteria on void fraction is, as I say, a factor of two with respect to the boiloff rate, and then we added additional conservatism acceptance criteria which -- with respect to twice the required flow, and that's how we get to the factor of eight conservatively.

CHAIRMAN CORRADINI: Just for clarification, the first bullet analysis based on is required by the ~~DVA~~ DBA assumption; is that correct? Or is that a judgment assumption --

MR. HEAD: It's a judgment assumption.

CHAIRMAN CORRADINI: It's a judgment on your part. It's not required by staff analysis.

MR. HEAD: It was one of those. Well, diesel starts, water flows. How soon could this kind of start, and we chose five minute.

CHAIRMAN CORRADINI: What is the required set of assumptions? It's left to the Applicant.

MR. VAN HALTERN: The required set of assumptions is that you should use the ANS 5.1 decay heat curve.

CHAIRMAN CORRADINI: Okay. I thought that I couldn't -- I guess I was trying to determine was it your choice or was it the guidance by staff, regulatory guidance?

MR. VAN HALTERN: No. This is essentially just a simplification, to come up with a simple conservative acceptance criteria.

CHAIRMAN CORRADINI: Okay, thank you.

MR. HEAD: But we really didn't see debris could get there in any meaningful sooner than that. So if we started there and it was acceptable, then obviously we had an acceptable test program and acceptable results.

Okay. Now, let me just ask. Are there any questions with respect to that summary? If not, then I'm going to go ahead and turn it over to Jim. He's going to go through all the previous meetings at a high level. We have a slide on bookkeeping, which shows all the follow-up items that the ACRS has asked us to address and how we close those.

And then, as I mentioned before, as topics come up, if there's any questions, we're certainly prepared here to answer any questions that we've either addressed before or new ones today. Appreciate that. Jim.

MR. TOMKINS: Okay. So as we've discussed, this is the fifth meeting on the subject, and this is just a list of the meetings we've already had. The first meeting was actually a meeting on Chapter 6 of the COLA, where we presented the departure, because we had to make a departure to upgrade the strainers, the state-of-the-art strainers we have.

In that meeting, we talked about strainer design. We presented the sizing analysis that we did on the strainers, and that was the first meeting where we introduced the post-COL downstream ~~field~~ fuel test. So there was a lot of questions about the downstream test at that meeting.

On 3/8/11, we made a couple of clarifications from the initial meeting. We clarified that the downstream test would use one cubic foot of fiber. We had actually initially proposed ten percent of one cubic foot. We didn't think all of it would really get through, but we changed that assumption.

DR. WALLIS: May I ask you about that? I'm sorry to bring it up again. I told my wife that you didn't know how many fibers were there, so you assumed a cubic foot, and she expressed surprise in some other statements too.

Suppose that one cubic foot is okay, but two cubic foot is not? I mean I've done some calculations, and it looks as if you might be okay with one cubic foot, but you might not be okay with two cubic feet. It seems to me you have to give some justification for why it's okay to stop at one.

It's just a number, as far as I can see. It's just a number someone picked up, and there's got to be some technical justification for it.

MR. TOMKINS: Okay. Well first off, we have none in the plant. So the only fiber that's going to be in there will be fiber that's left in the containment. We have, we think, a really good containment cleanliness program. I've done those walkdowns. I mean literally, you're going through containment picking up little things.

DR. WALLIS: I understand that, I understand that.

MR. TOMKINS: So we think one foot is a large number, plus we think the assumption that the entire one foot is all little fines that are going to go through the strainers, is not really --

DR. WALLIS: So you say something about the length of these fibers too?

MR. TOMKINS: Well, we have Tim, who will talk to you about the length of them. But they're all, they're short.

(Simultaneous speaking.)

MR. TOMKINS: Correct. That's the plan. So they're fairly little; they will --

DR. WALLIS: So there's no justification, except that it seems okay?

MR. TOMKINS: We think it's a conservative number, that's correct.

MR. HEAD: But we had some Japanese experience.

MR. TOMKINS: And we had some Japanese experience.

DR. WALLIS: You see, if you tried to go -- if you went before a public meeting and said it seemed okay, that wouldn't sound very technical.

MR. HEAD: We think it's very conservative.

DR. WALLIS: I know you think it's conservative.

MR. TOMKINS: We have experience from a Japanese plant and a Japanese --

DR. WALLIS: You do have some real basis --

(Simultaneous speaking.)

DR. WALLIS: So you can justify it? And if it turned out that two was not acceptable, you wouldn't do that test?

CHAIRMAN CORRADINI: Can I ask Graham's question in a different way?

MR. HEAD: Sure.

CHAIRMAN CORRADINI: Because, I mean, I'm struggling with this. You guys have, it kind of connects to Sam's question, because you guys have made a series of assumptions, which I will, at least from my limited review of all this, since I'm not, haven't been in all these fun meetings, seems conservative, a series of assumptions.

So if you became more realistic, does one become ten before you're a problem? You know what I'm asking? I'm trying to judge this, compared to all the assumptions you made, which look at me like an order of magnitude, in terms of if I take this and assume that and I assume that and I assume that, you then say I'll take some assumed amount of volume of stuff that is bad, and I'm okay.

But if it's really ten times that volume of stuff, because of all the conservatisms I've got to get to this point, that gives me some -- me, maybe nobody else on the Committee, gives me some feeling that you have an enormous margin. That's what I guess I'm --

MR. TOMKINS: We could take 100 cubic feet, because we can block the entire assembly and still cool it, based on our defense indepth is --

DR. WALLIS: You're not going to do the test with 100 cubic feet?

MR. TOMKINS: No, we're not going to do the test that way. But I'm saying --

MEMBER ARMIJO: Well, you know, I think --

MR. TOMKINS: --we can take more.

MEMBER ARMIJO: I'm on the same page as Mike. You might have answered Professor Wallis's question as we vacuumed up the Japanese ABWRs. We found a tenth of a cubic foot of stuff. We multiplied by ten and that's our margin.

But the basis for the one cubic foot is the question, I think, that Graham's asking.

DR. WALLIS: Right. If it turned out to be --

(Simultaneous speaking.)

CHAIRMAN CORRADINI: Gentlemen, please.

MEMBER ARMIJO: And you don't start with zero, because that's not real.

MR. HEAD: I'm going to ask Caroline to

review our basis for the one.

MS. SCHLASEMAN: This is Caroline Schlaseman with MPR, and I'm representing TANE and Toshiba. When we were -- I started off with the strainer sizing. Obviously, we had to figure out what kind of debris there would be on the strainer, and I have with me with the design specifications, the ASME design specifications.

So I have the listing of all the details of what all the debris assumptions are for the entire suppression pool, everything that's going to be in the suppression pool. Obviously, it gets distributed to different strainers, and based on flow rates and all that, and we had covered that in previous meetings.

The basis for the fiber, our initial position was well, there is no fiber. But in going back and looking at the experience from Kashiwazaki-Kariwa Unit 6 and Kashiwazaki-Kariwa Unit 7, which were the two operating ABWRs in the world, and both of them have -- one of them has been operating for a decade, and the other one is a little more recent.

But the older unit, the K-6 unit, we -- TEPCO provided the information to NINA. This is two and a half to three years ago, and the types of things that they found in their first suppression pool inspection, five years after operation, included things like little teeny bits of rope, little teeny metal pieces, little parts.

I mean there was a collection of very small stuff, and out of that, the amount that was actually fibrous material was again, really small, like well under a cubic foot. So we were trying to figure out how to quantify that, and we chose a cubic foot as a bounding -- that sounded like a pretty big number, based on the specifics of the TEPCO report of what they found.

I would have to pull it off my laptop computer, but I could show you. You know, they sent a two or three page report that actually gave us itemized detail of little ring on top of can, you know, little bit of rope that was two centimeters long, little bit of rope that was five centimeters long.

It was those kinds of things, none of which are small enough, unless they somehow get destroyed during the break and get pulverized into fines, which is what we're assuming for passing through our strainers, is that our initial position was zero, and obviously with discussions with the staff, zero was not licensable.

So we chose the one cubic foot, and we still believe it's a very conservative number.

DR. WALLIS: But you had gave us something hard here. Have you looked at the previous tests, such as the Owners Group test, to see how much fiber it would take to clog the craw? I mean that's a number -- I think you would have done that calculation.

Could you tell me what the weight of this one cubic foot is, because I'm -- calibrated in grams, and not in volume? Tim, what's the weight of that?

MR. ANDREYCHEK: 2.2 to 2.4 pounds per cubic foot.

DR. WALLIS: It's a bit heavier than that in the ANL test. Okay, okay. That's before it's squashed or something?

MR. ANDREYCHEK: That's the as-manufactured calculation.

DR. WALLIS: So you're going to put in 2.4 pounds; is that what you're going to do?

MR. ANDREYCHEK: Yes.

DR. WALLIS: And how many assemblies do you have?

MR. VAN HALTERN: 872.

DR. WALLIS: 800 assemblies?

MR. VAN HALTERN: 872. So actually put in 2.4 pounds, divided by 872, times the 70 percent penalty.

(Simultaneous speaking.)

DR. WALLIS: So the amount per assembly is on you. You have 800 assemblies?

MR. VAN HALTERN: 872.

DR. WALLIS: So that's the sort of calculation I would like for you to have done, not sort of say it seems all right, and here's some sort of hearsay evidence. Do a technical calculation and show that there's two grams per assembly, and all your Owners Group tests show blah blah blah; therefore, this is a reasonable assumption, and we're a long way away from something.

But just to sort of say one looks reasonable isn't good enough. I think you should be more hard-nosed and technical about it, because otherwise, someone's going to say well suppose it were 1.1 or 1.2? Is that a problem?

Another way to do the test is to say we'll put fiber in to find out when we get a problem, and if there's no problem below 30 cubic feet, then forget it. But the one is sort of intangible and fuzzy.

MR. VAN HALTERN: But we think conservative, though.

DR. WALLIS: But you're going to do something more than just this qualitative argument? No? Because if you get up in front of a technical public meeting, people are going to say where are they coming from? You can't discuss -- okay, I'm sorry. I've made my point, and I will put it in my report. But you've got 800 assemblies, 8-1/2 by 8?

(Simultaneous speaking.)

MR. VAN HALTERN: No. These are BWR assemblies.

DR. WALLIS: So what's --

MR. VAN HALTERN: It's about, if you -- the ratio, there's about the equivalent of three BWR assemblies --

DR. WALLIS: That's right. So I was thinking something like 200. I'm thinking of PWR.

MR. VAN HALTERN: Right. PWR is about --

DR. WALLIS: So I've to get this area. What's the area? We need to get the amount per unit area of debris at some level. You haven't calculated that?

(Simultaneous speaking.)

DR. WALLIS: These are things you can do in five minutes.

MR. TOMKINS: We can tell you, but not right now.

MR. VAN HALTERN: It's approximately 5 by 5.

DR. WALLIS: How much?

MR. VAN HALTERN: 5 by 5.

DR. WALLIS: 5 by 5.

MR. TOMKINS: Approximately.

MR. VAN HALTERN: Five inches by five inches.

DR. WALLIS: But the overall core area is about the same as a PWR?

CHAIRMAN CORRADINI: Just multiply 872 times 5 by 5.

MR. VAN HALTERN: It's bigger, because you have the gaps in between.

MR. TOMKINS: The gaps in between --

DR. WALLIS: It's bigger, it's bigger. So that helps.

MR. TOMKINS: You have all the gaps in between with control blades.

DR. WALLIS: That's good enough. Thank you.

MR. TOMKINS: Okay.

MEMBER ARMIJO: But basically you do have data? You do have fiber data from the Japanese plants. You could have said we found from the Japanese plants a tenth of a cubic foot of rope, rag, whatever it is, it's fibrous.

We multiply it by a big factor and we said one cubic foot's reasonable. But you can't start with zero, and I think that's Graham's point.

DR. WALLIS: Well, I would be happier if you had determined, by analysis and experiment, that it takes 50 cubic feet of fiber to block these things, and we're never going to get anything like that in there. But you're going to take another view, okay.

MR. TOMKINS: Right. We're taking a different approach.

DR. WALLIS: You can do that.

MR. TOMKINS: The other thing we clarified at the 3/8/11 meeting was chemical precipitates. Our initial position was that we weren't going to have any significant chemicals, and we changed that position as well. We now are including some chemical precipitates. We can talk about that in a little bit.

DR. WALLIS: You're going to get to that.

MR. TOMKINS: Yeah.

DR. WALLIS: Are you going to talk about the sludge and the rust?

MR. TOMKINS: I wasn't, but we can.

DR. WALLIS: Because I think was it Barseback that had the event that started this whole business? Was it Barseback?

MR. TOMKINS: Barseback, yeah.

DR. WALLIS: What I think happened there, it's a long time ago, was that they were surprised that the pressure dropped, and the pressure drop was bigger than they expected, and this caused some interest. The cause seemed to be that the sludge filled in the holes --

MR. TOMKINS: I think it was fiber with the sludge.

DR. WALLIS: Sludge played a very big role in increasing the pressure drop. So how are you going to model this stuff, which we know was not irrelevant at Barseback?

CHAIRMAN CORRADINI: Can I ask, since I don't remember this, a little more background for me. But we switched from downstream effects to the strainers.

DR. WALLIS: Are we talking about downstream?

(Simultaneous speaking.)

CHAIRMAN CORRADINI: I know, but historic, the thing that you're quoting, though, is what happened with the strain screens?

DR. WALLIS: Mr. Chairman, you've got fibers and if sludge fills in the gaps and blocks them, it doesn't matter whether they're on the a strainer or a claw or on your coffee machine. I mean it's the same physics.

CHAIRMAN CORRADINI: Right. But the only reason I'm asking is -- okay, fine.

MEMBER SHACK: He's just looking at a source of particulates.

CHAIRMAN CORRADINI: Fine.

DR. WALLIS: And how do you model these things, which turned out to play, as I understand, and we can check this out, an important role.

MR. ANDREYCHEK: We have four particulates that we're considering, right, and you can go through it with respect to dust and dirt?

DR. WALLIS: Are you modeling these things?

(Simultaneous speaking.)

MS. SCHLASEMAN: We have --

MR. TOMKINS: Go ahead.

DR. WALLIS: Are you modeling them though? How are do you -- I'm sorry.

MS. SCHLASEMAN: Based on the NUREG 6224, which is the strainer methodology, now I'm talking strainer sizing, the head loss for the strainer is determined based on several different debris types, and so for head loss calculations, I'm reading now out of the ASME code design specification for the strainers, that in the suppression pool, we have the one cubic foot of fibrous insulation.

We do not have any calcium silicate, because it is specifically forbidden in our unit. We have over 27,000 square feet of reflective metal insulation, metallic insulation, RMI. We have sludge, 195 pounds.

DR. WALLIS: 195 pounds?

MS. SCHLASEMAN: 195 pounds of sludge.

DR. WALLIS: That is a lot.

MS. SCHLASEMAN: It depends on --

(Simultaneous speaking.)

MS. SCHLASEMAN: Yes. For our plant, it is a lot, yeah. But it's, but that's the NUREG standard.

DR. WALLIS: How do you represent that in the test, so it can --

MS. SCHLASEMAN: That's going to be the --

DR. WALLIS: It seems to be more important than zinc oxide or any of these other things. I didn't see any description of how you're going to actually represent this stuff in a test.

MS. SCHLASEMAN: The sludge, the particulate, we'll be talking about the detail of what the surrogates are.

DR. WALLIS: From real sludge --

(Simultaneous speaking.)

MR. HEAD: No sir, we'll be using

surrogates.

DR. WALLIS: You've got to use the real stuff, because these surrogates can give you very unexpected effects.

MR. HEAD: We'll talk about that, you know.

DR. WALLIS: I think we need to talk to the staff about this too.

MS. SCHLASEMAN: That's not all of it.

DR. WALLIS: I mean you can't just put in something. You've got to put in something like the stuff you're going to get.

MS. SCHLASEMAN: There's more. So also, 85 pounds of paint chips --

DR. WALLIS: That's right, and there's some assumption about them.

MS. SCHLASEMAN: That's the destroyed epoxy coating. That's within the zone of influence of the break, of the qualified coatings, and where it is an inorganic zinc primer and epoxy top coat that's qualified for drywell, for primary containment use, and then 50 pounds of rust flakes, and 150 pounds of dust or dirt. So that's the soup.

DR. WALLIS: Well, these are all interesting, and I'm really impressed by the amount. How are you going to represent them in the test?

(Simultaneous speaking.)

CHAIRMAN CORRADINI: So I'm going to intervene at this point. Are you ready to do this later, so we can --

MR. HEAD: Oh no. I'm going to get to it. I'm just going to introduce, you know, or reintroduce, and we discussed this in this meeting.

CHAIRMAN CORRADINI: Okay.

MEMBER ARMIJO: But before you get to that, this 195 pounds of iron oxide and everything else. Now you, I thought you have stainless steel liners?

(Simultaneous speaking.)

MEMBER ARMIJO: It's going to be hard to generate that unless you're awful --

MR. TOMKINS: Sir, but it would be also hard to come up with a different number. So we agree that that will be the challenge that's in front of us, and instead of saying it's really 100 or more likely 10, because of the suppression pool cleanup system and the way we designed the plant, we felt like it was more appropriate just to stay at this expected test --

DR. WALLIS: But you've got to be careful, because if you do realistic tests with real sludge, you may find that this is a problem.

MR. TOMKINS: Well, we don't expect that, based on the calculations --

DR. WALLIS: Don't expect everything with regard to behavior of debris and sludge and stuff like that. Don't expect anything.

MR. TOMKINS: Well, we have to expect something, or we wouldn't --

DR. WALLIS: Well, I know, but it's a dangerous field to expect things in.

MR. TOMKINS: I recognize that, and I'm sure, as we'll talk about in a second, in terms of the surrogates that we're going to use, that there's --

DR. WALLIS: But that will be good. How are you going to represent the sludge?

MR. TOMKINS: Right now, we're going to discuss the surrogates that we're going to use for all these --

(Simultaneous speaking.)

DR. WALLIS: That's the question I'm after. How are you going to represent these?

CHAIRMAN CORRADINI: Okay, okay.

DR. WALLIS: That's the only question.

CHAIRMAN CORRADINI: Let's get out of a conversation mode. So let me just make sure that all the Committee heard, because you did it quickly. Of course, a cubic foot of powder or 200 pounds of sludge.

How much paint chips? I apologize, from the guide?

MEMBER ARMIJO: Fifty-some.

MS. SCHLASEMAN: 85 pounds.

CHAIRMAN CORRADINI: Okay, and then there was one other dirt?

DR. WALLIS: 50 pounds rust flakes, 15 pounds of dirt.

MS. SCHLASEMAN: No, 150 pounds.

MR. TOMKINS: Let me bring up the slide.

MR. HEAD: 150 pounds of dirt.

DR. WALLIS: 150 pounds. That's right.

MS. SCHLASEMAN: 150 pounds of dust and dirt.

DR. WALLIS: What is dirt?

MR. TOMKINS: Okay. So here's the --

MS. SCHLASEMAN: That's how it's defined in the NUREG.

CHAIRMAN CORRADINI: So have we missed anything from the list, before we go on to the surrogates?

MR. TOMKINS: Here's the list.

CHAIRMAN CORRADINI: Okay, thank you.

MR. TOMKINS: This is what we presented in 3/8/11 meeting.

DR. WALLIS: Could we have that slide?

Could you give us that?

MR. TOMKINS: Yes. We gave it, you have it.

MR. HEAD: You have it. It's from that meeting. It's from the March 8th, 2011 meeting.

MR. TOMKINS: So we can go through the surrogates for each one of these.

DR. WALLIS: No. I just want to know that there are all of these things, that's all.

CHAIRMAN CORRADINI: Okay. Keep on going.

MS. SCHLASEMAN: It might make sense to clarify --

MR. HEAD: If you have questions like that, of a perspective, since you weren't involved, and as I mentioned before, we'll be able to pull up any previous discussions. We want you have them all, and so clearly, you know, we can make them available to you now or after the meeting.

CHAIRMAN CORRADINI: I'd rather you get back to what you planned to do, because I think the open discussion that Dr. Wallis is after is what do you plan to use for the surrogates. So you can talk about it now or later, but we get back to the surrogates.

MR. ANDREYCHEK: For the paint chips, we used paint chips. For particulates --

DR. WALLIS: You used paint chips?

MR. ANDREYCHEK: Pardon?

DR. WALLIS: Size spectrum of some sort or what?

MR. ANDREYCHEK: Well, we used -- we can create a size spectrum, based on creating a sheet of epoxy on top of plastic, and then you roll it in a --

DR. WALLIS: So you're going to use realistic paint chips?

MR. ANDREYCHEK: As best we know it, yes.

DR. WALLIS: Good, thank you.

MEMBER BLEY: You were about to tell us how you did it. You paint it on plastic and then you roll it up --

MR. ANDREYCHEK: No. You take the plastic, you put it -- there's a couple of ways you can make the chips. Take, you shake it up, plastic, put it into a large can on a mandrel, throw some ball bearings in and just roll it for a period of time, and that will create your chips. We've done that in a couple of different --

DR. WALLIS: And this is what happens in a LOCA?

MR. ANDREYCHEK: What happens in a LOCA is it blasts, you get a jet blast. But, you know, we're not going to necessarily create a LOCA to try to get paint chips --

DR. WALLIS: So there's an assumption here that ball bearings and LOCA produce the same kind of paint chips?

MR. ANDREYCHEK: About the same size chips.

MEMBER SHACK: Well, what is the size of chips? What does that distribution look like?

MR. ANDREYCHEK: Well, the distribution could be anywhere from about a quarter of an inch to something smaller than that.

DR. WALLIS: Something smaller? Did it get down to microns?

MR. ANDREYCHEK: Possibly. Might become epoxy dust.

MEMBER SHACK: I mean the FPL test with the pressurized water got down to like 50 microns.

MR. ANDREYCHEK: That's correct.

MEMBER SHACK: And so you aim it at something like that or --

MR. ANDREYCHEK: Come up with -- well again, if you look at what we're required to do, we're required to come up with chips that will either block the strainer, if that's what you're worried about, or pass through the strainer and create debris that you need to consider downstream.

DR. WALLIS: What I read, and maybe I misread it, is that, I'm quoting now, "that the coating particles are assumed to be 10 microns spheres."

MR. ANDREYCHEK: That's for zinc.

DR. WALLIS: Isn't this part of the coating?

MR. ANDREYCHEK: That's the backside of it. That's the primer coat.

DR. WALLIS: Oh, that's behind. What you're talking about is what's in front?

MR. ANDREYCHEK: The epoxy, the epoxy coat, yes.

DR. WALLIS: Okay.

MR. ANDREYCHEK: And then for --

MEMBER SHACK: And then you're going to dissolve the inorganic zinc?

MR. ANDREYCHEK: The inorganic zinc doesn't necessarily dissolve. When you heat it up, it will become a little tacky. But it doesn't necessarily dissolve. If you have something along the lines of a polyurethane, that will dissolve, and actually even humidity will dissolve that. But epoxy coatings don't dissolve.

MEMBER SHACK: No. The inorganic zinc, it dissolves.

MR. ANDREYCHEK: Inorganic zinc will not dissolve either. The inorganic zinc will oxidize and create a zinc oxide type of material over time, and as we said earlier, in one of the summary statements, it takes on the order of around 15 days. You're better to --

MEMBER SHACK: I thought you assumed that it dissolved and then precipitated in zinc oxide, or that you used 10 micron particles, which represent presumably less of things that get through the strainer?

MR. ANDREYCHEK: Exactly, exactly.

MR. TOMKINS: Remember, for the zinc, we're assuming aluminum hydroxide as --

(Simultaneous speaking.)

MEMBER SHACK: I mean yeah, the chemical precipitate, rather than a particulate. But again, you're using -- the 10 micron particles are basically what you think are going to get through the strainer, and come to the downstream effects?

MR. ANDREYCHEK: Correct, correct.

MEMBER SHACK: So I mean we can go through the whole discussion of all of your chips and all your sludge, but what you're using for the downstream test is essentially 10 micron particles.

MR. ANDREYCHEK: Correct.

MR. TOMKINS: But we're assuming all the zinc gets through.

MEMBER SHACK: That's right.

MR. TOMKINS: I mean none gets caught on the strainer.

MEMBER SHACK: Right.

MR. TOMKINS: It all gets into the --

MEMBER SHACK: It all gets through, for various reasons.

MR. ANDREYCHEK: Right, and the zinc, the formation -- all the zinc gets through, but we simulate it in the test as aluminum hydroxide.

DR. WALLIS: It gets through the strainer, but it won't get through the debris on the fuel?

MR. ANDREYCHEK: Correct.

DR. WALLIS: Why is it different? I mean if it's getting through a fiberglass debris, a fiberglass deposit on the strainer --

MR. ANDREYCHEK: It's a conservative approach.

DR. WALLIS: It won't get through the fiberglass that's on the --

MR. TOMKINS: Well, we'll test that and find out.

MR. ANDREYCHEK: It's a conservative approach, and unless you test it --

MEMBER SHACK: But I think with their one cubic feet, they're likely to have open areas on their strainers.

(Laughter.)

MEMBER SHACK: Even Graham might agree with that.

DR. WALLIS: Anything that's smaller than the hole in the strainer will get through.

MR. TOMKINS: Right, and the hole in the strainer is 2.1 millimeters.

DR. WALLIS: But it's fairly big, right?

MR. TOMKINS: Well, so all the particulate gets through, with the exception of the RMI shards.

MS. SCHLASEMAN: And the epoxy top coat. That's only 38 pounds for our epoxy top coat. That's the size distribution.

CHAIRMAN CORRADINI: Oh, can you -- I'm sorry. Could you just repeat? Jim said it, and then you kind of clarified. But what do you assume gets through out of this list? The epoxy is stopped. The RMI shards, I assume, are stopped.

MS. SCHLASEMAN: Right.

MR. TOMKINS: Not all of them. Some get

through.

CHAIRMAN CORRADINI: Some, because of their distribution.

MS. SCHLASEMAN: Right.

CHAIRMAN CORRADINI: But the assumption is other than those two, everything we see here is assumed to pass through the strainers?

MR. TOMKINS: Yep.

MS. SCHLASEMAN: That is correct.

CHAIRMAN CORRADINI: Okay.

MR. TOMKINS: And gets to the fuel.

MS. SCHLASEMAN: Part of them, because of the size distributions. There were 85 pounds for strainer head loss for epoxy coatings, and there were only 38 assumed to pass the strainer, based on the distributions.

CHAIRMAN CORRADINI: Okay, okay.

MR. HEAD: So that 38 is going to challenge the fuel?

MR. ANDREYCHEK: That's correct.

MS. SCHLASEMAN: It's assumed to pass the strainer, yes.

MR. HEAD: This is fuel.

MS. SCHLASEMAN: This is debris assumptions for the downstream effects.

CHAIRMAN CORRADINI: Okay. That's what I wanted to make sure I understood.

MS. SCHLASEMAN: So that's what the first column is. So the first number, the epoxy coating of 38 pounds, is less than the 85 pounds that I told you would be used for the strainer head loss calculation, and then the RMI shards, again that's much, much smaller than the, you know, 27,000 square feet of destroyed RMI. That's how much of size distribution would pass through the strainer.

CHAIRMAN CORRADINI: Okay. So let's just take us back to why we went to this slide. So Dr. Wallis asked about surrogates. So Tim started off by saying the epoxy is the epoxy. So what do you use for your fake sludge?

MR. ANDREYCHEK: Sludge, dust and dirt, and the -- we'll be looking right now at using silicon carbide, and the size distribution, we will be reviewing what the industry is doing and come up with the appropriate size distribution.

DR. WALLIS: So there won't be the 10 micron size? This doesn't say micron in the paper work?

MR. ANDREYCHEK: That's right.

DR. WALLIS: It won't be 10 micron size?

MR. ANDREYCHEK: But I also believe that

that same paper work states that we'll be following the industry, what the industry is doing, and we will make modifications as necessary.

DR. WALLIS: Now didn't your Owners' Group test show you that 10 microns goes right through the fiberglass, most of them?

MR. ANDREYCHEK: Actually, no it didn't.

DR. WALLIS: It didn't?

MR. ANDREYCHEK: And what we found, I'm looking at the test and looking at when we pulled the assembly part to clean it, was that the fiber bed had debris throughout the fiber bed.

DR. WALLIS: Well, it had debris in it, but a lot of the product was run right through.

MR. ANDREYCHEK: I think what you'll find, and this depends on how much particulate you actually had, the fiber bed did in fact become saturated, and because of the nature of the design, the open lattice structure --

DR. WALLIS: I read your report, and it was clear that the particles went right through the bed, went around the loop about 30 times without being trapped.

MR. ANDREYCHEK: I think you'll find that in those particular tests, and I won't disagree with you that some of it did continue around, but you found --

what we found was that the fiber bed became saturated with particulates, because we were using, in some tests, very, very large amounts.

The tests were very low, very close to a 1 to 1 ratio. The water became very clean, because the fiber bed did in fact collect most of the --

DR. WALLIS: I think it's somewhere else, Tim. But if you used all those huge number of particulates, that if they had got trapped, I calculated you'd get pressure drops of hundreds or thousands of psi, which you never got.

So that's the kind of reasoning that led me to conclude, based on lot of other stuff, that a lot of these 10 micron particles went right through a fiber bed. I'm sure that a lot of the sludge isn't as small as 10 microns. So it seems to me completely unrealistic to assume that all this stuff has a size of 10 microns.

You've got to put in realistic sizes, and some of these particles are going to be much bigger than that, because the holes in the strainer are 2 millimeters, and this was like 2,000 microns?

MR. ANDREYCHEK: That statements said we will follow --

DR. WALLIS: What was the magnitude?

MR. ANDREYCHEK: We will follow what the

industry's doing. We'll take a look at --

DR. WALLIS: I don't think you should follow what the industry's doing. You should follow what makes sense. If the industry isn't doing the right thing, you've got to do the right thing.

MR. HEAD: Let me address that, if I could, because I think that was a very important part of our previous meetings with respect to this discussion before us, is that the test protocol, including sizes, the concoction, how added, when added, temperature, everything is in an evolutionary state, both the BWRs and the Owners' Group, the BWRs.

We made the commitment on the docket, and it was not -- it was something we were already doing to follow the industry evolution, and if the protocol changes and as it changes, by the time we do the test, we will do the state of the art test at that point in time.

DR. WALLIS: You're very wise to say that, yeah.

CHAIRMAN CORRADINI: I don't know. I guess hearing that, I'm not sure what else they can say.

MR. HEAD: Well but it's important, because we need to agree on something that the staff would say was appropriate, that you would say is important, the industry says is important, and it's in a time of state of flux.

DR. WALLIS: Well, I would be happy if you really thought about it yourselves too, and said what you know. Sometimes what the staff says may not always be physically very sensible. May not always be. I'm not saying it isn't always, but sometimes it might not be. So you have to think about it yourself.

MR. HEAD: We do, and that's why picking, choosing what we think is a surrogate, including the aluminum hydroxide that we talked about is the most challenging, we believe, this has been part of our thinking all along. But we really felt like from a licensing perspective, an industry perspective and even an ACRS perspective, to concoct something that has no basis --

DR. WALLIS: Well, you just said aluminum hydroxide is very, very important?

MR. HEAD: We think in terms of challenging, in terms of the gelatinous mass. So we've thought about it.

DR. WALLIS: Well, but it turns out if you put in silicon carbide, it doesn't do anything.

MR. HEAD: And if that's what the industry and the staff concludes two or three years from now, when you know, everyone it comes to say hey there is -- that's the appropriate challenge for sludge, and maybe here's a different challenge for dust, and here's what you ought to do for rust.

If that is the appropriate creation for the test, then that's what we'll use to close our license condition that's associated with --

DR. WALLIS: I think you also need to think yourselves, because if it turns out that this knowledge evolves, you've done the tests and then something comes up that says they weren't any good, you know. You've got to think ahead of time, that make darn sure you do the right test. Now the other thing --

CHAIRMAN CORRADINI: Hang on, Graham. Before you move on, I want to make sure we --

DR. WALLIS: I'll just say one other thing.

CHAIRMAN CORRADINI: But if I might.

DR. WALLIS: Yes.

CHAIRMAN CORRADINI: So we've addressed epoxy coating. I'm sorry. I'm linear about this.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: I understand. You've answered the point about sludge in terms of inventory amount and essentially staying current to what the distribution was. Dust and dirt?

MR. ANDREYCHEK: Well, we used the same, silicon carbide.

CHAIRMAN CORRADINI: Okay. So for both sludge and dust and dirt, the surrogate is silicon carbide.

MR. ANDREYCHEK: As it stands right now today, yes.

CHAIRMAN CORRADINI: Okay, and the distribution, as Graham was asking relative to what it is, what you say it is right now, to what it may evolve to, is still in what we'll call you're going to follow what industry is doing?

MR. ANDREYCHEK: Correct.

CHAIRMAN CORRADINI: But I think --

DR. WALLIS: I noticed in the SER that the staff approved the use of 10 micron silicon carbide. That goes back to some EPRI thing and so on and so on.

MR. ANDREYCHEK: That's correct.

DR. WALLIS: So as of now, you would be within the regulations to say we'll use 10 micron silicon carbide?

MR. ANDREYCHEK: That's correct, right. But we have a commitment that we will send the NRC six months prior to doing the test, our truing up with industry experience with downstream tests. That's their --

DR. WALLIS: I think you should make a very sincere effort to properly represent the sludge, the dust and the dirt, and if you get results which are incompatible with the NRC assumption, you might well be right.

MR. HEAD: Yes, sir, but that would put us in an awkward position with respect to closing the license condition.

DR. WALLIS: That's right, that's right.

MR. HEAD: And so that's something that we will have to address at that point in time, and part of addressing that is staying involved with the industry. We do participate in the Owners' Group, okay. You know, we have a number of different people that participate with the BWR Owners Group. We obviously have PWR Owners Group affiliation, as part of this project.

So we're going to -- we're going to stay abreast of this evolution as it takes place, and when we do that test, we will know that it's like saying it's the state of the art, and we believe -- and we also believe it's an appropriate test at that point in time.

And I think most of that insight that we provide, though, will probably come as part of a member of the Owners Group, as opposed to us doing something totally different. I think that would put us all in an unusual place, for us to --

CHAIRMAN CORRADINI: I think -- well, just so we continue to move on, I think what at least I hear Dr. Wallis is saying is that following the industry practice is fine, but you should follow it in an informed fashion.

MR. HEAD: Yes, sir.

CHAIRMAN CORRADINI: If you find something out that would modify the industry's --

MR. HEAD: And we'll have that option. When we submit our test protocols six months ahead of time, and if we say we're going to use, you know, something else as a surrogate, the staff can clearly at that point in time say yeah, we think that's a better way to go.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: And we would head that way.

CHAIRMAN CORRADINI: Okay. So we're --

DR. WALLIS: --as much as possible not to use surrogates, because it is a complicated process, and you can do things that -- surrogates may have different properties that you don't know or aware of from the real stuff.

MR. HEAD: We take it. We understand.

CHAIRMAN CORRADINI: Anything else in terms of we're down to rust flakes. How about rust flakes?

MR. ANDREYCHEK: Rust flakes would be iron oxide, the iron oxide, or again, we might use another surrogate for that. Current thinking right now. We could use iron oxide. RMI shards would be RMI shards.

CHAIRMAN CORRADINI: And latent fiber you had --

MR. ANDREYCHEK: Fiberglass, for practical purposes. In the aluminum, both precipitates, aluminum zinc will be aluminum oxyhydroxide.

CHAIRMAN CORRADINI: I'm not a chemical effects person, so I'll turn to the Committee if they have an issue.

MEMBER SHACK: No. We've accepted that essentially for all the testing and --

MR. ANDREYCHEK: There's been testing that's been demonstrated, found by NRC to demonstrate to aluminum oxyhydroxide, of the precipitates evaluated, is the worse for head loss on a fiber bed.

CHAIRMAN CORRADINI: Okay.

DR. WALLIS: This wasn't demonstrated, but it was sort of argued that nothing could be worse than oxyhydroxide.

MR. HEAD: However, in the meantime, if something is discovered --

(Laughter.)

MR. HEAD: --and it works, okay, then that clearly would be something we would avail ourselves of, as part of closing the license condition.

CHAIRMAN CORRADINI: So let me ask a question that's not in the last four meetings, and I don't understand the connection. So I'm sure my colleagues will tell me I've got to be quiet. So the other part South Texas is trying to do a risk-informed approach on this.

MR. HEAD: Yes, sir.

CHAIRMAN CORRADINI: This just seems to be screaming to do something that's a bit more realistic than this, because this just looks like -- so my question is besides staying abreast of what the industry is doing from a deterministic standpoint, are you staying abreast with what South Texas was doing?

MR. HEAD: I was here as part of helping brief, and those are my colleagues for many years. You know, I know what they're doing. But they're doing a risk-informed approach for them and the industry for existing plants.

We've made most of the risks that they're talking about, and they're trying to model zero, we believe zero.

CHAIRMAN CORRADINI: So let me just ask the question differently. But to the extent that that's true, and they, whenever you do these tests; let's not try to guess an actual chronological date. It seems to me their methodology you could put your inventory through, and actually see the margin that you have, and see what seems to be an enormous margin.

Do you see what I'm getting at? In other words, they're developing a methodology. With that methodology, you can apply it to all of this. I would expect that where they have a worry of where the danger zone is, you're way below it.

It seems the demonstration of how big of a margin you've got, to me would be extremely important, so that all this in some sense dissipates, because you have, from a plant design standpoint, eliminated as --

DR. WALLIS: Well, you might continue to know where disaster is. You don't know what the margin is. So unless you do the tests up to the point where you find out you've actually clogged something, you then don't know how much of a margin you have from that clogging, unless you've done that test, do you? You get the point?

CHAIRMAN CORRADINI: I understand the point.

DR. WALLIS: You can be conservative.

MEMBER BLEY: But you do know up to the point at which you test it.

DR. WALLIS: You do --

MEMBER BLEY: There's many places where we can't test a failure or destruction. So we have to live with that.

CHAIRMAN CORRADINI: But what I guess I'm saying is, this maybe you can say it and I'll ask it, this is not a risk-informed approach. This is a deterministic approach that has built into it a series of conservative assumptions that, at least in my mind, are one piled on top of another, on top of another.

So I have, at least in my mind, have a hell of a time trying to figure out where the hell the problem is and where you're operating. It just seems -- so my first point, it's not a risk-informed approach clearly.

MR. HEAD: Well, in some ways maybe it doesn't look like that. But from my perspective, it is, because we're taking the risk off the table. I mean we are making some of the risks that STP 1 and 2 happen to deal with, which is a real number.

We're basically trying to make it zero, and then adding something to it, because we're actually challenging with stuff we're not thinking we're going to have.

MEMBER STETKAR: But I think, Scott, what you're hearing a little bit, forget about risk and sort of the traditional notion of risk. Think about risk in terms of evaluating uncertainties about parameters that you use in an analysis, distributions of sizes, distributions of the amount of material that would require to get to failure. Think of that in the context of the distribution for the frequency of, you know, the size of an earthquake or anything else.

In that sense, you're not doing a risk-informed analysis. You're not looking at those probability distributions or your uncertainties. You're doing what I would call a classic design basis analysis, that you pass a certain set of criteria and you've not evaluated things past that.

MEMBER BLEY: I think the weakness is what you're seeing. It's when you stack all of these supposed conservatisms on top of each other, when someone as Professor Wallis challenges you one of them, it's real hard to see how the others compensate for that one.

So you have to live with that in what you're doing. So you're always vulnerable to what if you get one of these wrong, and you don't know how they interact.

MEMBER STETKAR: You don't have a quantitative assessment of --

MEMBER BLEY: Right.

MR. HEAD: Which is part of our defense indepth, is that we will never fail. We will always keep the core cooled, but we believe that even with respect to the risk-informed approach you're talking about, if there are some insights that come out of that which the industry is participating in, and the industry says "hey, that's a good distribution to apply to rust," based on the analysis they're doing, then that will ultimately, I think, evolve into the analysis for the test program that we'll do.

CHAIRMAN CORRADINI: Okay. That's a fair thing. Let's keep on going. I'm sorry.

MR. HEAD: So that was the bookkeeping discussion.

CHAIRMAN CORRADINI: And we'll get a copy of the bookkeeping slide, just in case some of us may have missed where it went.

MR. HEAD: Maitri has all of them.

MS. BANERJEE: Can I get a copy now?

CHAIRMAN CORRADINI: Maitri has it and will get a copy to us, so we can lose it again. Keep on going.

(Laughter.)

MS. BANERJEE: I'll make a copy.

MR. TOMKINS: Okay. Got that first bullet wrapped up. That was easy. So the second point at the March meeting, we provided a comprehensive presentation on long-term cooling, and we went over the ECCS and the heat sink, and showed that they were more than adequate to provide cooling for 30 days.

We addressed the challenges. The challenges are debris impacts on NPSH of strainers, containment integrity, downstream effects on fuel, which is the one we spent the most time on, and ECCS gas accumulation. As we've said many times, we had a very detailed discussion in that 3/8/11 meeting on downstream fuel testing.

We also presented the defense indepth analyses, showing that high pressure core flooder from above the core, and fuel assembly bypass flow. Each of those, which by itself can provide adequate cooling for the core, even if the assembly were to plug completely.

So again, that's our bounding. We're going to do a test. We're confident we're going to pass the test, but even if those assemblies were to plug, we think we'll get cooling to the core and we're okay.

On 6/21/2011 and 10/4/2011, we addressed a series of follow-up items, and I'm going to present those next. So this is the -- this is probably the slide we can delve into detail. We've already gone into some, but if you look, this is all the action items.

There have been 19 follow-up items from ACRS. The "O" means that was the meeting they were open; the "C" is the meeting they were closed. So you can -- there's a range. I mean there are, some were what was the boron concentration in the sodium pentaborate tank? One was give us a briefing on vacuum breakers, which we did.

CHAIRMAN CORRADINI: We like vacuum breakers.

MR. TOMKINS: Pardon?

CHAIRMAN CORRADINI: Nothing.

(Laughter.)

MR. TOMKINS: Yeah, and we take care of them. We're nice to them. Provide TOSHIBA with the technical reports. Then there were some more significant ones. Use of NUKON as a fiber surrogate, use of aluminum oxyhydroxide as a chemical surrogate. A lot of things we've already started discussing were covered in the 6/21/11 meeting.

You can see there's one that's still open, and that's Action Item 80, relating to the pressure drop versus flow exponent of 2.0 that we're just -- I plan to discuss that next.

Maitri, I think that agrees with your accounting?

MS. BANERJEE: That's correct, yes.

CHAIRMAN CORRADINI: She's the accountant, right. I'd go broke.

MR. TOMKINS: Okay. So you know, we talked about inlet flow distribution assumption. We did a parametric study of the results versus the assembly and K-factor. We had a discussion on modeling of the perforated strainer screen in holes. Caroline did that, and then there was a question on zinc oxide concentration.

So we can, you know, our belief is these are closed, but we can go back and delve into any of them, if you want to talk about them.

CHAIRMAN CORRADINI: Just so the Committee knows, the way they've structured this is they next want to talk about, I can't remember the number -- number 80, thank you, and there it is, number 80. So they're going to go into that in great detail. But I think before we go there, I want to make sure the Committee has the chance to ask them other detailed questions.

(No response.)

CHAIRMAN CORRADINI: All right. We're dying for 80.

MR. TOMKINS: Before we go to 80, I just want to summarize. So from all the four meetings, for all the four meetings, here's, as Scott mentioned, our position has evolved in how we're going to do this task, and here's four things that we've changed so far.

We're going to include 100 percent of the one cubic foot in downstream fuel tests; we are going to include chemicals now in the downstream testing. We're going to perform multiple tests. We're actually going to test two separate flow rates, and then we're going to perform three to six tests at each of those flow rates, to make sure we understand uncertainties.

You know, I think everyone would agree, this process is somewhat random, in terms of how debris forms. Then the last one is the big one, which is we're going to review industry experience. We have membership on both the PWR and BWR Owners Groups. Milton Rejcek, sitting back there, is regularly attending the BWR Owners Group.

So we'll, anything we learn from them, we will put into our program, and that will be provided to the NRC six months before we do the test. So there's a commitment in the FSAR that we will do that. So it will be their opportunity to disagree with us, we didn't catch this, what about this.

And I think it's realistic that we probably will make some changes, changes on the tests.

MEMBER BLEY: In the beginning, you said you were going to do this, I forget what you told us, some time before --

MR. TOMKINS: Eighteen months.

MEMBER BLEY: Eighteen months, a year and a half.

MR. TOMKINS: That's required by license condition to be performed 18 months prior to operation.

CHAIRMAN CORRADINI: So the commitment on your side is to have them done and to the NRC for analysis or for review?

MR. TOMKINS: Right.

CHAIRMAN CORRADINI: Okay.

MR. TOMKINS: And then this other commitment is to give them the procedure six months before we --

CHAIRMAN CORRADINI: Before the -- thanks.

MR. HEAD: All of which is related to closing a license condition.

CHAIRMAN CORRADINI: Right.

MR. TOMKINS: And I suspect the NRC will participate in the testing. I think that's very likely, when we actually do it.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: So I guess the only thing I wanted to get back to, because I've written it down and I see where Dr. Wallis is coming from, is that, and let me ask it this way. So from your standpoint, you have provided the technical basis for the one cubic foot?

MR. TOMKINS: Yes, sir. We think so.

CHAIRMAN CORRADINI: Okay. So I guess I'd like to -- I think the Committee would like to see it, so we can reflect on it. That's another way of kind of getting to, I think, what Graham is asking.

And then from the standpoint of the inventory, which we now all have again, and some of us never had but now have for sure, you're doing assumptions on -- you know, you said it and I didn't write it down. Where would I go for the details of what you currently think is the, what I'll call, size distribution and surrogate composition for each of these, if you have decided to use a surrogate rather than the real thing? Can you remind me where I go look for that?

MR. ANDREYCHEK: Well, there's a couple of places that it would be. For example, we talk about the --

CHAIRMAN CORRADINI: Well, I guess what I'm asking Tim is if the Committee wants to go back and just review where it is, given that it can evolve, but what you have committed to to this point, is it in your -- what documentation would we go to, to look at -- besides inventory, but inventory, current list of materials, whether they be surrogate or real, and assume size distribution?

MR. ANDREYCHEK: I believe most of that information would be in the presentations that we gave over the course of responding to open items here.

CHAIRMAN CORRADINI: It doesn't sit, it doesn't reside in one place?

MR. ANDREYCHEK: I don't believe it does.

CHAIRMAN CORRADINI: Could we get -- I believe they're in tables. Can I get a table that it all resides on one place?

MR. ANDREYCHEK: Sure. I can do that.

CHAIRMAN CORRADINI: That would be very helpful.

MEMBER ARMIJO: It is. It's basically an expansion of this table.

CHAIRMAN CORRADINI: It's an expansion.

MR. ANDREYCHEK: We'll just add a column or two to that table, if that's what I'm hearing.

CHAIRMAN CORRADINI: That would be really good

MEMBER BLEY: You don't have anything like that now?

MR. ANDREYCHEK: Not currently, no.

CHAIRMAN CORRADINI: That would be a helpful guide to all. Is that, Dr. WALLIS?

MEMBER ARMIJO: It would help me.

CHAIRMAN CORRADINI: Okay.

DR. WALLIS: I'm still puzzled by what dirt is.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: You clearly haven't been to my house.

MEMBER ARMIJO: But you know, along those lines, what is the official definition of sludge? The only thing I know that it isn't is silicon carbide. So what is, in a real power plant, I always envisioned sludge as an iron oxide goop that was at the bottom of the suppression pool. Is that what --

MR. ANDREYCHEK: Yes, yes.

MS. SCHLASEMAN: That's how it's defined in the NUREG 6224. 6224 defines --

MEMBER ARMIJO: So why not use iron oxide, getting back to Professor Wallis's --

MEMBER BLEY: Why in this case use a surrogate? I understand when you use surrogates for something that's very hazardous. But why use a surrogate for iron oxide?

MEMBER ARMIJO: Right, and why put so much iron oxide when you have stainless steel lined suppression pools? You know, I think -- I'm going to give my speech one last time. I think you guys are painting yourself into a corner with conservatisms upon conservatisms upon conservatisms, on a test that may turn out to give you problems to pass.

You think you're going to pass them, but then you're going to go to your bypass flow and other conservatisms and try to pencil whip your way out of a problem that you created yourselves. I just think you're painting yourselves into a corner by unrealistic assumptions and testing.

CHAIRMAN CORRADINI: So you have two questions here. The second part of it sounded more like a comment. But the first part was I guess I did want to hear from you guys. So you've chosen to use carbide as a surrogate.

Why not what you think is at least the

majority composition of what sludge is? That's, I think, where you started.

MEMBER ARMIJO: Yeah.

CHAIRMAN CORRADINI: Could you comment on that from the --

MR. ANDREYCHEK: The thought process was it's silicon carbide is easily available. Make the sludge requires additional time, effort, in order to dig it out. I mean you've got to create the rust in order to create the sludge.

CHAIRMAN CORRADINI: Choosing to make rust.

DR. WALLIS: Take an old vehicle and scratch it.

(Simultaneous speaking.)

MR. ANDREYCHEK: --because they're going to be several tests that are going to be run. So I agree with you in concept. It's very easy. But that's --

MR. HEAD: But it's also one of those -- I mean there's an industry, an operating fleet that's dealing with this, and some sort of consistent test that we've agreed to, with some sort of a consistent protocol is important for the operating side.

CHAIRMAN CORRADINI: So here's a -- you don't get a chance this time. So here's a counter to that, because I don't disagree with that. You've got to stay with the industry, or else -- but an inventive experimenter might say okay, we're going to do all our tests with silicon carbide.

But we'll do two tests in two extremes with the real stuff, just to see if I see a difference. That's, I mean I know, I've been around Professor Wallis long enough that I have this sense that that's what one might do from a test program standpoint, is you do all of it with the industry-evolving standards. But then just in case, you do a couple to show that there's no difference with the --

DR. WALLIS: The risk is you do all your tests, and then some academic in some Midwestern university, because he's curious, does a test with the real stuff, and gee whiz, the pressure drops 100 times as much. That's the real danger you have, and it's not a good thing to face.

CHAIRMAN CORRADINI: We've made our point, I think.

MR. HEAD: Mr. Chairman, I think at this point in time, what I think I've heard is two follow-up items.

CHAIRMAN CORRADINI: Correct.

MR. HEAD: Okay, one is the basis on the one cubic foot.

CHAIRMAN CORRADINI: Well, you have it. We would just like to see it, okay.

MR. HEAD: That seeing, is that in a meeting, or is that after the breakout or --

(Simultaneous speaking.)

MS. SCHLASEMAN: I need to download it.

CHAIRMAN CORRADINI: We'll let you guys -- we trust you and we promise not to, I promise not to lose it. So if they lose it, they'll get it again. So it doesn't have to be in a meeting standpoint. It can be essentially a follow-up communication, all right. The second thing is just essentially expand your --

MR. HEAD: Okay, and is that in a follow-up?

CHAIRMAN CORRADINI: It can be a communication. We understand in both cases at least, and I'm going to speak for the Committee. We understand in both cases where you guys sit. You've given us a verbal technical basis. We'd like to see it, a communication.

You've told us by verbally going through the back and forth, what the inventory is and what you currently think is the distribution and the surrogate. I'd just like to see it summarized. So it doesn't have to -- we don't have to call you back in.

DR. WALLIS: Are you going to get it summarized so you can do the test?

CHAIRMAN CORRADINI: No. I just want it summarized, so I have it somewhere, okay.

MR. TOMKINS: So I can work with Maitri as to how we accomplish that?

CHAIRMAN CORRADINI: Sure, yep, yep.

MR. HEAD: Or the staff. We'll want to make sure the staff is involved in that interaction. But we certainly can submit something or provide it to Maitri, however is appropriate.

CHAIRMAN CORRADINI: Okay. We're ahead. Officially, we're doing Item 80 at 10:15. But can we take a break now, and read ahead and get ready for number 80.

(Laughter.)

CHAIRMAN CORRADINI: All right. So I'd like you back at five after, at 10:05. We'll take a break.

(Whereupon, the above-entitled matter went off the record at 9:49 a.m. and resumed at 10:08 a.m.)

CHAIRMAN CORRADINI: Okay. We're back in session. Jim, you're going to take us through the follow-up item?

MR. TOMKINS: Uh-huh.

CHAIRMAN CORRADINI: Right, okay.

MR. TOMKINS: So this is follow-up item 80, having to do with the basis for the test acceptance criteria that uses an exponent of --

CHAIRMAN CORRADINI: Jim, could you move your mic around a little bit, so it's closer, just so -- we also want the recorder to pick up everything.

MR. TOMKINS: Thanks.

CHAIRMAN CORRADINI: He really can't hear. He's just using the recorder as an excuse.

(Laughter.)

MR. TOMKINS: Okay. So this is the acceptance criteria. What it basically says is when you run the test, the final pressure drop over the initial pressure drop, that ratio has to be less than 1,200 times the ratio of the final flow over the initial flow squared.

And the two is the exponent we're talking about, and that is based on the Darcy equation, and that's what we used in the analysis.

DR. WALLIS: Darcy is one, isn't it? Darcy is also laminate, and it doesn't matter. I think Darcy is always one.

CHAIRMAN CORRADINI: I think turbulence is what they're -- yeah.

MR. TOMKINS: Yes, we are. We think the exponent of two is a reasonable value for high debris loadings. So when we look at testing, when you get a lot of debris loaded onto the fuel assembly, it does follow the exponent of two.

But some have suggested that well maybe you should be using a different exponent. So we've done a sensitivity and we've looked at what it would look like if you use 1.5 or 1.2. That's sort of summarized on this colorful picture. Hopefully, that will jar everybody.

But this is -- so the Y axis is the ratio of pressure drop, and the X axis is the ratio of flow. Red is the zone where you'd have an unacceptable test ~~task~~. So every test ~~task~~ will define a single point on this curve.

So the equation we just talked about, with the 1,200 in it, is this line right here. Just going back to that, one thing I didn't mention is the analysis would actually support 4,800 being in there. So we reduced it by a factor of four in pressure drop, which becomes a factor of two in flow. So that was something we, you asked about, is what's that factor?

CHAIRMAN CORRADINI: You reduced the Y? I apologize.

MR. TOMKINS: Just for conservatism, for

the fact that our understanding of this is imperfect, and we wanted to make sure if we get a result that it's a result we can rely on.

CHAIRMAN CORRADINI: So where does that factor of four fit into your colorful curve?

MR. TOMKINS: I'll show you. I'll show you. Okay. So 1,200 is this curve; 4,800 is this curve. So in other words, the green could actually go all the way up to here, if we just followed what the computer code said. We follow the acceptance criteria. So we decided to lower it, make it harder to pass the test.

Now if you put in exponents of 1.5 as this line and 1.2 as this line. So those variations in exponent are within the margin we have defined for the acceptance criteria, which is kind of exactly why we put it in there.

CHAIRMAN CORRADINI: I'm sorry. I don't mean to sound confused, but I'm confused. So you're telling me the delta P ratio equals constant delta P ratio squared, is that line there?

MR. TOMKINS: Right.

CHAIRMAN CORRADINI: That line.

MR. TOMKINS: Well, the previous curve, this curve right here, this equation right here is this line.

CHAIRMAN CORRADINI: Okay. So you can't --

MR. TOMKINS: If you put 4,800, you get that line.

CHAIRMAN CORRADINI: Well then it can't be 1.2 or 1.5. It's got to be the reverse of that. What am I missing?

MR. HEAD: I'll start with the 4,800 curve.

MR. TOMKINS: The 4,800 curve has an exponent of two in it.

CHAIRMAN CORRADINI: Okay.

MR. TOMKINS: If you go back to this, it's just this relationship, 4,800 there, ratio squared.

DR. KRESS: So if the 4,800 curve was 1.5, that would be --

MR. TOMKINS: Right, yes. 4,800, 1.5 would be here; 4,800, 1.2 would be here. Still bounded by what we've assumed.

MEMBER ARMIJO: And the bottom one is the only one that uses a 1,200?

MR. HEAD: That's correct.

CHAIRMAN CORRADINI: Okay, thank you.

(Simultaneous speaking.)

DR. KRESS: So if you -- so here's the 1.5

and --

CHAIRMAN CORRADINI: Welcome, Dr. Kress.

DR. KRESS: Yes, thank you, and the 1,200, then they would be down below the green that you have now?

MR. TOMKINS: No. Well yes, if we ratio it --

(Simultaneous speaking.)

DR. KRESS: That was the problem with the question in the first place.

MR. HEAD: But then we might not have selected to use the factor of two, the conservatism --

DR. KRESS: Yeah, that's an important concept.

MR. HEAD: You know, we've chosen those two curves. If it's something different, we might have concluded well okay, that's an inappropriate conservatism at that point in time. So --

(Simultaneous speaking.)

MR. HEAD: --something that looks like that bottom green.

MR. VAN HALTERN: If I can add just one thing. We were asked to come up with an acceptance criteria, in a simple form that could be used easily. We have not run the tests, and we're not -- I have not been trying to predict how the test is going to perform for any amount of debris. We haven't run it.

We don't know what protocol we're going to use, you know. It could be for some, you know, completely different thing. But the code tells you what flow rate, what pressure drop will give you a flow rate that gives us our .95, which is about twice the boiloff rate. That's what the upper curve does, based on the code, using just a reduction of the inlet.

CHAIRMAN CORRADINI: It's essentially a K loss factor.

MR. VAN HALTERN: That's correct, that's correct.

CHAIRMAN CORRADINI: Okay.

MR. VAN HALTERN: We knew at the time that there could be variations in how debris accumulates or how that responds, particularly over a wide range of flow. That was one of the reasons why we put in this margin, the safety factor, a margin factor, because essentially we don't want to get to the point where we're right at the acceptance criteria limit. We want to make sure that there's margin, as part of the defense indepth.

DR. KRESS: There's been a lot of tests with just the filters themselves. They're generally run around two. Did you, is that your experience with it?

MR. VAN HALTERN: We have not run -- we have not run the BWR tests. But Tim -- say that one more time, to make sure I understand, Dr. Kress?

DR. KRESS: There's been a lot of test filters of this nature, without debris or without blockage.

MR. VAN HALTERN: Right.

DR. KRESS: And they generally run around two in the exponent.

MR. VAN HALTERN: That is correct.

DR. KRESS: Yes. I just wondered if that, I'm not quite familiar with these particular filters. But I just wondered if that was your experience with them when they're unblocked and clean.

MR. VAN HALTERN: When they're clean filters, there was clean assemblies, no debris whatsoever, they do match the Darcy equation, with the factor of two as an exponent.

DR. KRESS: Yes.

MEMBER ARMIJO: If you run a number of experiments, and you get data points falling in this cross-hatched margin region, what do you do then?

MR. TOMKINS: Oh, I think our expectation is that's not going to happen.

MEMBER ARMIJO: Right. So I'm sure that

you have that. I don't have a doubt about that. But I'm just saying what -- is there real margin or do you --

MR. VAN HALTERN: Several options. You have several options, right. One is that you change and it has to go through the licensing process. You have to change the debris assumptions. That's one option.

Another is to not use that as an acceptable fuel design, and have a different fuel design. The third would be to go back and justify a relaxation of some of this margin, based on the information that you've got. All of those would have to go through the Commission for approval.

So you don't know until you've done the test. I think that's Dr. Wallis's point all along.

MR. TOMKINS: But I think our expectation is that if we run four tests, that they should all be below the curve, and if they're not, then --

(Simultaneous speaking.)

DR. WALLIS: I understand what you're doing, and I thought there wasn't an issue at all when I looked at it, because you do a test. You measure a flow rate and a pressure drop. The computer has a K.

The only way you can take the test result and put it in the computer is to take that test, take the flow rate and the pressure drop, give it a K based on two, and put it in the computer.

The computer only deals with a K modeling two. So you can't, when there's no sense in representing power law if it were some other flow rate, because the test has one flow rate and one pressure drop, and it has a K. It has nothing to do with how we would vary if you changed the flow rate. So that's what you have to put in a computer is a K, and you get the K from the test.

MR. VAN HALTERN: So when you --

DR. WALLIS: K has nothing to do with how it varies with flow rate. K is simply flow rate.

(Simultaneous speaking.)

MR. VAN HALTERN: To come up with acceptance criteria like this, it's analytic-based. Basically, it is a pressure drop and a flow rate --

DR. WALLIS: But it has a K.

MR. VAN HALTERN: And so when you run the test, you may not get that same flow rate.

DR. WALLIS: You run a test, you get a flow rate representing reality.

MR. VAN HALTERN: Well, based on the test condition and the way you run the test, you'll get a flow rate which is different from that.

DR. WALLIS: Well then you extrapolate to a different flow rate.

MR. VAN HALTERN: So then there's -- essentially there's two things you do when you run the test. You have to, you want to normalize or the results to the test, a clean versus a fouled test. You want to correct that. You may do that by zeroing out your DP cells at a certain flow rate clean, or you may do that, in this case, by just normalizing, okay. So that you're measuring the change in conditions.

DR. WALLIS: So you're testing not the actual flow rate; you're testing some other flow rate than you expect in the reactor?

MR. VAN HALTERN: When you run, you will be, you will get a different flow rate. You can get a different flow rate, and you have to adjust back. In some of the other testing things, they used different relationships, and that's where a lot of those studies came, with the different exponents, to correct back to the test condition, to the acceptance criteria condition.

Here, I just -- we adjust the acceptance criteria to give you a range, so whatever flow rate you're at is consistent with the acceptance criteria.

CHAIRMAN CORRADINI: I'm listening to what he asked, and I'm listening to how you answered, but I'm, at least in my mind, I'm still fuzzy. So let me just make sure I get in this simple thing, that I got this right.

So the delta p of i and the mass flow rate, W of I, is when you kick off --

MR. VAN HALTERN: The reference condition.

CHAIRMAN CORRADINI: When you kick off the test with no added debris, that's what the loop resistance is for the test?

MR. VAN HALTERN: Correct.

CHAIRMAN CORRADINI: Now you start throwing in crap, highly organized and decided junk. But you throw in stuff, and now you get another delta P and another flow rate.

DR. WALLIS: So you've got another K, because it's, that's the way K is defined.

CHAIRMAN CORRADINI: Well, but as I understand, I'm just -- if I might. If I understand what you're saying is the ratio of the Ks should be 4,800, but you're assuming it's 1,200?

MR. VAN HALTERN: It's got to be less than 1,200.

CHAIRMAN CORRADINI: But what Professor Wallis is saying, I think that's the way I was thinking about this. Essentially, the test will give you the K ratio.

DR. WALLIS: Right, it does.

MR. TOMKINS: Okay, and we want to make sure the test results had a lower K ratio increase than the analysis showed us would cause a problem, with a void fraction of .95 at the top of the hot assembly. So that's the acceptance criteria. So in other words, you put the debris in; the amount of blockage and the amount of K increases better be less than what it was in the analysis.

(Simultaneous speaking.)

DR. WALLIS: --the model is K, because that's what it's based on.

MR. TOMKINS: They changed the area actually, but yes, that's effectively K.

CHAIRMAN CORRADINI: Okay, fine. So I guess we're on the same page, but let me just say it back so we're -- at least I'm there, is that this 1,200 is a -- what's driving me nuts is this 1,200 is a dimensional quantity.

It's essentially a square of an area is flying around in there, because that's what's causing it to go out. You're essentially squishing down, you're squishing down on the flow area by throwing in the junk, as well as potentially changing the flow regime or whatever it is so the K is different.

But it's that ratio that you're trying to estimate, and as Dr. Wallis is saying, you do the test, you get a K ratio, and that's what you have to live with. You're looking to see what that K ratio is relative to --

MR. TOMKINS: The analysis.

DR. WALLIS: To the analysis. Now when does the power level, power law come into it?

CHAIRMAN CORRADINI: It doesn't. They have to assume a power law to do the analysis.

DR. WALLIS: To do the computer, you have to put in a two.

CHAIRMAN CORRADINI: Or the Excel spreadsheet.

DR. WALLIS: -- from the experiment. I don't quite understand why you need to worry about if you had a different flow rate, how it would change. That was the way I looked at it. I just thought this index is irrelevant. But I don't quite know what you've done.

MR. VAN HALTERN: Well, I think the question was --

MR. TOMKINS: We were asked to do a sensitivity on it, if we used a exponent of 1.5 or 1.2

--

DR. WALLIS: If you had modeled with a power law of 1.5, you would have had a different kind of a K, yes, correct.

(Simultaneous speaking.)

DR. WALLIS: But that's not what the computer did. The computer modeled it with two. So in terms of the computer model, this is okay. You have 1,200 margin. If the computer chooses to go back and model with 1.5, then you have a different --

MR. VAN HALTERN: And that's the -- those are the lines we plotted.

DR. WALLIS: But you didn't do that, did you?

MR. VAN HALTERN: Yes, we did, yes we did.

DR. WALLIS: You put this in the computer?

(Simultaneous speaking.)

DR. WALLIS: You put that in the computer when you modeled to this .95 and all that stuff, .95 exponent?

MR. VAN HALTERN: It's the same, the same set of conditions if you use a 1.5 as your exponent, and you put that curve.

DR. WALLIS: So Wi and to the Pi will model with 1.5 as well?

MR. VAN HALTERN: Not the Wi.

DR. WALLIS: It has to be, because it's underneath. It's inside.

MR. VAN HALTERN: That's not what happens.

DR. WALLIS: It has to be.

MR. VAN HALTERN: You get a different relationship.

DR. WALLIS: Well, I don't understand what you've done.

CHAIRMAN CORRADINI: Can I take another stab at it, because I do want us to at least understand. So you've done a side calculation with, and I can't remember the tool.

MR. TOMKINS: GOBLIN.

CHAIRMAN CORRADINI: I'm sorry?

MR. TOMKINS: GOBLIN.

CHAIRMAN CORRADINI: GOBLIN, thank you. I was going to say there was all sorts of funny names, but so it with GOBLIN.

We're in the Halloween season, and you then said that at 95 percent void, you had defined that as a point. So at 95 percent void, the flow rate you need to essentially keep the core under those flow conditions, and then you then backed out the delta P, right?

MR. VAN HALTERN: That's correct, that's correct.

CHAIRMAN CORRADINI: And you have this relationship, which is everything below the solid line. Your analysis, and that's why I guess I want to make sure I got it right. The analysis at .95 is the 4,800 line or the 1,200 line?

MR. VAN HALTERN: 4,800.

CHAIRMAN CORRADINI: Okay. So the dash line at the very top is the one that would essentially provide you with a void fraction, such that you're well within the PCT and life is nice and cool?

MR. VAN HALTERN: Correct, very cool.

CHAIRMAN CORRADINI: Okay. Then you consciously decreased that by a factor of four as a margin, and stuck in the solid line, and everything below that is that. So in the model for GOBLIN, it assumes turbulent conditions, and therefore to Dr. Wallis's point, it only knows turbulent conditions, so its got two buried in it.

So once we're done with that, the computer is out of the picture, and it's simply a matter of just throwing where the data sits relative to the two lines?

MR. VAN HALTERN: Correct.

CHAIRMAN CORRADINI: Okay. Then I'm okay.

DR. WALLIS: Well, I don't understand. The computer says that you'll be in trouble when you have a K of something, right. You do an experiment, you measure delta P and W squared and you've got a K, and that K is a thousand times smaller, so you're okay. Everything, that's okay.

CHAIRMAN CORRADINI: That's right.

DR. WALLIS: You don't have to ask how it would be if you happen to have a different flow rate.

CHAIRMAN CORRADINI: Well, I would say don't dwell on -- if I might, just a suggestion. Don't dwell on the 1.5 and the 1.2. Just dwell on the fact that the dash line and the solid line, and their point is their GOBLIN analysis says that they're well within accruable geometry when the dash line is met, and they've consciously taken it down by a factor of four, and they want to see that they sit within the green zone.

MR. HEAD: And we also felt this approach was appropriate for closing the license condition.

CHAIRMAN CORRADINI: Right. But I think Dr. WALLIS, and I'm kind of with him on this, the two lines in between are kind of red herrings, to pick another word for it.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: I wasn't here, so I

don't know. But all I know is that the two extremes make perfect sense, because your more sophisticated calculation gives you the dash line, your solid line essentially an assumption, and okay?

DR. WALLIS: Yes.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: Thank you.

CHAIRMAN CORRADINI: I'm sorry, go ahead.

MR. TOMKINS: So that's really it. I mean the --

DR. WALLIS: I still don't know what you did. Are we going to be able to see what you did?

CHAIRMAN CORRADINI: Well, they haven't did anything yet.

DR. WALLIS: I don't think it matters, but I'm just curious of what on earth you did.

MR. VAN HALTERN: That is what we did.

DR. WALLIS: But you can't. You have to have a K. Everything is based on K. You can't fudge it and say it's something else.

CHAIRMAN CORRADINI: I think Graham, all they're saying is, if you go back to the curve, and then I'll stop. All they're saying is, is that based on their GOBLIN analysis, plus a factor of four reduction in their margin. So it's not .95 void; it's, I don't know, whatever the associated void is in the green zone.

DR. WALLIS: But they do the test. They do the test. The WF, is that the actual condition they expect, as predicted by the computer, isn't it?

CHAIRMAN CORRADINI: No, Wi is predicted by it. We do the test -- not necessarily.

DR. WALLIS: Now when you get this K where you're in the trouble --

CHAIRMAN CORRADINI: But can you answer his question, because I think that's where maybe he's confused.

DR. WALLIS: But you say you need a certain amount of water to cool the core, and it's double blowdown ~~boredown~~ condition, so we'll do the test at that flow rate. Don't you do that?

Don't you do the test at the flow rate that you need to cool the core? The only question then is what's the pressure drop, because the flow rate's fixed, and this defines the K, because the other p over w gives you a K.

MR. VAN HALTERN: Ask about is the flow rate, as you add debris will change, okay. So you start at some flow rate and you add the debris and it ends up at a different flow rate and the pressure drops.

CHAIRMAN CORRADINI: So let me interject.

Then I think what he's asking is what flow rate do you start with, and that's the range of initial flow rates.

(Simultaneous speaking.)

DR. WALLIS: But they said we're going to get the flow rate we need to cool the core, and then we're going to see where pressure drop begins.

MR. VAN HALTERN: Correct. That's the way--

DR. WALLIS: You're going to do it the best way you --

MR. VAN HALTERN: We could do that as well.

DR. WALLIS: You've got in debris. How do you know what flow rate to use?

MR. TOMKINS: We start with a flow rate that's representative of post --

(Simultaneous speaking.)

DR. WALLIS: Conditions. Okay. So you find, okay. I see what you're doing.

CHAIRMAN CORRADINI: That's what I -- so I want to make sure you're clear about what flow, the W of I they start with.

DR. WALLIS: Oh, I know what Wi is --

(Simultaneous speaking.)

MR. TOMKINS: 16 gpm and 80 gpm are the two values that we have.

MR. VAN HALTERN: The questions that have come before us previously were don't you have to test the different flow rates, because you get debris bed formation differently. Well, so you start with a clean condition and you start at a flow rate, add your debris, and it will --

DR. WALLIS: And your --

MR. VAN HALTERN: And your flow rate will decrease and your pressure drop will increase.

DR. WALLIS: Flow rate is decreased according to the GOBLIN analysis, as the pressure drop builds up?

MR. VAN HALTERN: We control that in the test.

DR. WALLIS: You control that in the test, okay, okay. Is this written up somewhere so we can actually follow the logic? I mean this doesn't tell me what you really did.

MR. VAN HALTERN: I think it's in the COLA.

MR. TOMKINS: Yes. It's in, it's an RAI response.

MR. VAN HALTERN: It's in RAI response.

CHAIRMAN CORRADINI: There's an RAI response. We got a CD, and there's an RAI response in their test protocol, and that's where it would be.

DR. WALLIS: Actually gives the math and the method?

CHAIRMAN CORRADINI: I would assume they have the test procedure.

MS. BANERJEE ~~SCHLASEMAN~~: It's in the CD.

CHAIRMAN CORRADINI: It's described generally, but that may not be --

MS. SCHLASEMAN: I think it was one of the RAIs.

MR. TOMKINS: I can find the RAI.

CHAIRMAN CORRADINI: Would you please?

MR. TOMKINS: Yes, and that's something --

DR. WALLIS: When you do the test, your GOBLIN comes down.

MR. TOMKINS: Well, GOBLIN doesn't -- when we do the test. GOBLIN isn't doing it.

DR. WALLIS: But GOBLIN taught you how to control flow rate versus pressure drop, doesn't it?

MR. TOMKINS: No. GOBLIN just tells us --

(Simultaneous speaking.)

DR. WALLIS: Well, how do you know how to do the test then? How do you know how to do the test?

CHAIRMAN CORRADINI: I think all that GOBLIN does, if I may just interject Graham, GOBLIN essentially gives them the dash line at top.

MR. TOMKINS: This line right here.

CHAIRMAN CORRADINI: That line. They then consciously add margin and take what GOBLIN predicts to be the loss coefficient and decrease it by a factor of four, and that's their line of acceptance.

DR. WALLIS: So how do you do -- how do you control the flow rate on the test? I thought that you were trying to model what happened in a real event, by letting the pressure drop increase across the core and then decreasing the flow rate correspondingly? Don't you do that?

MR. TOMKINS: Well, the pressure drop does increase, of course, when you start adding debris. So flow rate starts decreasing.

DR. WALLIS: Why does it go down?

MR. TOMKINS: Pardon?

DR. WALLIS: Why does it go down?

MR. TOMKINS: Because there's more resistance.

DR. WALLIS: But then your pump, you're following a pump characteristic. You're not following a core characteristic, the core in the pump. You're not trying to model the actual accident with the pump. Some people actually try and follow the accident and say as you build up pressure drop, the flow rate goes down.

MR. TOMKINS: Right, right.

DR. WALLIS: You don't do that?

MR. VAN HALTERN: Our intent at this point was not, but we'll learn from the industry, see what makes sense.

MR. HEAD: This was a license condition that was, you know, simple, and if it accommodated the adjustment --

DR. WALLIS: But I thought we were following -- if you follow, try to follow the accident, so as the pressure drop builds up the flow rate goes down, then you're following essentially a GOBLIN model.

So when you get a certain point where you stop, you're actually on a certain point in the GOBLIN prediction, because you're following a GOBLIN curve. That's what I thought you were doing. If you're there, you have a K.

CHAIRMAN CORRADINI: Can I interject one more -- I don't think you have -- let me just ask. You don't have more to present?

MR. TOMKINS: No.

CHAIRMAN CORRADINI: So I think we've got to get it clear in our minds, and again, what I heard them say, I guess I interpreted it differently than what you just said. What they're saying is they've done the

GOBLIN calculation for reflood, and they basically asked themselves a question.

Parametrically, if I continually decrease the flow for reflood, or I should say long-term cooling, and I just invent some resistance and turbulent, assumed turbulent conditions, at what point do I get above 95 percent void fraction, which is the surrogate for dryout? It's not dryout; it's the surrogate for dryout, and they get the dash curve.

MR. TOMKINS: Right, right.

CHAIRMAN CORRADINI: And then they then say well, there might be some uncertainty here, so we're going to take that down and increase the resistance further, and they take it down to the green region.

Then after that, the GOBLIN calculation is essentially not necessary anymore. Now they have a window. Now then they have a test protocol which you're after, as to how do they determine where they sit between green and red.

What I thought you said was they then take what they expect to be the W of i, start the test, and then add debris under some protocol.

MR. TOMKINS: Correct, and when we get steady state, we have a final pressure, we have initial pressure drop, final flow and we have the initial flow, and that's plugged into that.

DR. WALLIS: How do you control the pump characteristic, so that your responsive flow to pressure drop is realistic? You have to design the -- what are you trying to simulate in the test? You can design a pump which is always pumping the same flow rate, no matter what, to simply build up pressure drop.

MR. TOMKINS: Right.

DR. WALLIS: Or you could have a pump which decreases flow rate as the pressure drop builds up, and you can stop flow and you get a certain pressure drop. So that now which of those are you doing and how does that relate to GOBLIN?

I thought you were trying to follow a GOBLIN -- there's a GOBLIN curve of pressure drop and flow rate and there's a resistance curve and they meet, and that's where you are.

MR. VAN HALTERN: Correct, right.

DR. WALLIS: But you're not trying to do that?

MR. VAN HALTERN: Well, we would be approximating, and you can control that through --

DR. WALLIS: Approximately on the GOBLIN curve?

MR. VAN HALTERN: Yes. You would try to

approximate that.

DR. WALLIS: Okay. So --

MR. VAN HALTERN: But the problem, you may not get to the GOBLIN final flow rate, because you wouldn't get to the debris resistance that you get for a 4,800 curve, right?

CHAIRMAN CORRADINI: Graham, are you okay? I want to make sure. We have the time to make sure you at least understand what they're saying.

DR. WALLIS: Not to the point where I fully understand what you're doing. But I'm not sure of either one.

MR. TOMKINS: I'd be willing to.

CHAIRMAN CORRADINI: Yes, Caroline.

MS. SCHLASEMAN: Well, I just want to understand. Are you talking about like the RHR pump, I mean as it -- I mean is it the loss? When you were talking about the strainer --

DR. WALLIS: No. I'm saying the reactor system has a certain characteristic. There's a certain flow rate versus pressure drop.

MR. VAN HALTERN: In the GOBLIN scenario, okay, you have a LOCA. You essentially fill the downcomer with a head of water. That head stays constant. You're in natural circ.

DR. WALLIS: That's right.

MR. VAN HALTERN: And then as your resistance changes, what happens is you, more of the pressure drop is taken up by the resistance and the head of water in the fuel drops.

DR. WALLIS: That's right, and GOBLIN predicts the relationship within flow and pressure drop for the loop, apart from the blockage.

MR. VAN HALTERN: Yes, for that --

DR. WALLIS: Then you have a little curve coming up here. Where they meet is your operating point?

MR. VAN HALTERN: That's correct.

DR. WALLIS: I'm saying if you follow the GOBLIN curve, it doesn't really matter what, how you make the debris or anything. You're always on that curve, so you always have a K, because GOBLIN has a K.

MR. VAN HALTERN: No, I understand.

MR. TOMKINS: And so really what the test does is it says, you know, that increase in K, that in the analysis that led to the void fraction of .95, we'd better be less than that in the --

(Simultaneous speaking.)

DR. WALLIS: But the problem you have --

MR. TOMKINS: --and we put in a factor of four to make sure.

DR. WALLIS: The problem you have is if you do a test which has conditions so far away from the GOBLIN curve that you have to extrapolate a lot. That's where you get in trouble, and I don't know how far away you are.

MR. VAN HALTERN: I think we're reasonably close, in terms of both rates, the initial flow rate at least.

DR. WALLIS: I mean if GOBLIN is predicting flow rates of, I don't know, five gallons per minute per assembly or something at a certain pressure drop, and you're a way away far from that, then you may want to extrapolate in some way, to get those to meet.

But I don't -- until you show me that sort of analysis, I don't really understand what you're doing. I think I did it some time, to convince myself it was okay. But I don't see -- this doesn't tell me anything.

MR. VAN HALTERN: So your question is on the test protocol.

CHAIRMAN CORRADINI: Yes. I think what we're getting to is not the criterion; it's on the test protocol.

MR. VAN HALTERN: Protocol, correct.

DR. KRESS: Graham, I would be pleased if I knew that they were operating on the top curve, which is specific to the ECCS. If they're operating on the flat part, they never get down to the part where it decreases.

MR. TOMKINS: Remember, ECCS isn't in play per se here, because what's driving the flow is natural circ --

DR. WALLIS: Natural circulation.

DR. KRESS: This is natural circulation?

MR. TOMKINS: Yes, at this point, yes, because all the water that still goes in from ECCS spills out of the break --

DR. WALLIS: They're complicated.

MR. VAN HALTERN: Essentially you have a constant head of water, upstream of the assembly.

CHAIRMAN CORRADINI: Right.

MR. VAN HALTERN: Okay, and the flow will change as the resistance of that assembly changes.

DR. WALLIS: GOBLIN will predict the pressure drop?

MR. VAN HALTERN: Yes.

DR. WALLIS: Flow rate characteristic for the core and that stuff, and you have to match that with the other resistance from the debris. That's all.

They've just two curves intersecting.

Now say if you do the test to really model reality, you will intersect at a realistic point, and that will have a K. You don't have to correct anything, because K is -- this curve has a K as a parameter.

MR. VAN HALTERN: So what you're suggesting is that we follow the flow versus time in GOBLIN, as we increase the resistance?

MR. TOMKINS: It's part of the test protocol, and we will make sure that the test protocol provides --

DR. WALLIS: You don't have to have time in there; you just have to have flow rate. GOBLIN predicts flow versus available pressure drop through the debris.

MR. TOMKINS: Right.

DR. WALLIS: The big stuff.

MR. TOMKINS: Right.

DR. WALLIS: So it predicts -- it has a K right away. If you're on that GOBLIN curve, you have a K. You don't have to correct anything. But if your test is way away from that reality, then you have to extrapolate. Maybe that's what you're doing here.

MR. TOMKINS: That's part of why we have that equation, is because the flow --

MR. VAN HALTERN: The K will change with the debris.

MR. TOMKINS: So the flow might be a little different in the test. We're going to start at the same point.

DR. WALLIS: If it's a little different, it's not going to make much --

CHAIRMAN CORRADINI: So let me back us up a bit, because we're kind of -- I want to make sure we have time for the staff to address the Committee. So a thing that we should be reminded of is the RAI response, so we can look at the test protocol as you've responded to staff.

And what Dr. Wallis is asking, which I think I understand, is what is that test protocol versus at least what he expected it to be, since we -- let's just say we don't remember what we have somewhere in one of our hard drives, for the RAI response.

Then you also said there's a summary of the test protocol, but I can't remember where you said the summary was.

MR. VAN HALTERN: I think that was in 6C.

MR. TOMKINS: 6C has a summary of the protocol, but --

MS. SCHLASEMAN: I see it.

MR. TOMKINS: --it also has a summary of the analysis, validating the acceptance criteria.

MR. VAN HALTERN: A high level summary.

DR. WALLIS: But you are setting the flow rates that you're pumping through this debris to be pretty well what you're expecting --

MR. VAN HALTERN: Right.

DR. WALLIS: --when you get to this point where you don't cool the core.

MR. VAN HALTERN: Right.

DR. WALLIS: So you've got to be on that GOBLIN curve pretty realistically so you have a K. So I don't think there's a problem at all. I don't see how you could have such tremendous difference here.

CHAIRMAN CORRADINI: The tremendous difference is strictly an assumption.

MR. TOMKINS: Right. The factor of four is a tremendous difference. That's, yes.

DR. WALLIS: You're predicting a different curve there for --

CHAIRMAN CORRADINI: It's not their prediction. That's essentially their assumption. The dash line is what GOBLIN is saying is a set of conditions that will allow the core to stay cool. The solid line is what they assume.

DR. WALLIS: You can't change that.

MR. TOMKINS: The bottom line is what we use for the test and what we assume, and in essence, the test is doing what you say, because it is determining you've got a pressure drop and you've got a flow. So it's determining K.

DR. WALLIS: So it's determining a K.

MR. TOMKINS: So you're --

(Simultaneous speaking.)

DR. WALLIS: Absolutely, right. That's what we're trying to do.

MR. TOMKINS: So that's what that line is doing for us.

DR. WALLIS: Right. So why do you have to change it?

CHAIRMAN CORRADINI: Okay, all right. Anything else for the Committee, and Banerjee will catch up.

(Laughter.)

DR. WALLIS: If we can read the transcript.

CHAIRMAN CORRADINI: Go ahead.

(Simultaneous speaking.)

MR. TOMKINS: So in summary, we think we've addressed all the ACRS follow-up items. We understand we've got a couple of documents we're going to get to ACRS. We've written those down. There's three things we're going to get to you. Scott will cover that.

We think there's adequate core cooling to meet long-term cooling. Both the ECCS and ultimate heat sink are more than adequate to provide the 30 days required, and as we've said before, the design basis LOCA peak clad temperature about half the limit. So we have a mild LOCA, if you will.

The challenge is that we've talked about containment integrity, ECCS gas accumulation and strainer NPSH were satisfactorily addressed in previous meetings. The primary challenge that we see, and certainly we -- certainly from the perspective of the amount of time we've spent on it was debris passing through the strainers and causing downstream effects.

We have a conservative downstream test. Acceptance criteria, you know, is a factor of four. There's a whole bunch of -- the .95 is conservative. So we think if we get a positive test in the downstream test, then we'll be very confident that debris would not compromise long-term cooling in the plant.

Furthermore, we have defense indepth, so that really even if the strainers plug completely, there's two other means. They have the high pressure core flooder, which a lot of plants don't have. They can inject water from the top, and we have bypass flow, which we've calculated and determined that that can provide sufficient cooling.

So we think we meet the regulatory requirements for long-term cooling.

DR. WALLIS: And you don't have any risk analysis of what happens if you do completely plug the bottom of the core. Maybe the risk is very small.

MR. TOMKINS: Well, our analysis shows that we can still cool it.

DR. WALLIS: No, but there's got to be a probability of that too, so you're within the PRA.

CHAIRMAN CORRADINI: So may I ask, again just for my personal reference, your last sub-bullet of "Furthermore," dot-dot-dot, where would I find the analysis that shows where the high pressure core flooder or the bypass of the assembly would essentially keep you within an acceptable --

MR. TOMKINS: It's described in various RAIs, and it's described in 6C also. But it's in a calc. I mean that's where really most of the details are. Is that correct Marty?

MR. VAN HALTERN: Yes.

CHAIRMAN CORRADINI: And I'll turn to Maitri to provide it to the Committee. But I just want to, since you made the point from a defense indepth standpoint, that you have essentially two alternate means, I want to actually make sure we can get back to that. Thank you.

MR. HEAD: And at this point, I'd like to summarize what I think our actions are, at this point. One is that you wanted to understand the basis for the one cubic foot of debris, and we'll work with the staff on providing -- I think we'll get, you know, we'll docket something to provide that.

We probably won't provide the actual TEPCO report, but a derivative document or something that, and we'll --

MS. SCHLASEMAN: What I was going to say is I've just given Maitri a copy that we can show. It's a TEPCO proprietary document that's governed under STP's and NINA's relationship, and she has it, and we can show that, and we have shown that to the staff before. Rather than document --

MR. HEAD: You can't leave it, though, right?

MS. SCHLASEMAN: Right, we can't docket.

CHAIRMAN CORRADINI: Well, I'm not going to docket the report.

MS. SCHLASEMAN: But I'm just saying we can show that now.

MR. HEAD: Yes. We can show it and show its existence, but in terms of leaving it --

(Simultaneous speaking.)

MR. HEAD: We can't, because it -- we'll probably summarize that in this document we send you. We'll show you the report exists. NRC has seen the report.

MS. SCHLASEMAN: It's in the early RAIs also.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: Right.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: Okay, that was the first item.

MR. HEAD: We're not leaving the report.

MS. SCHLASEMAN: That's correct, we're not. It's TEPCO proprietary.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: And the table that we talked about, in terms of the different sources of debris, which goes into what the surrogate is and some indication of the basis for that, you know, in terms of where in the industry that's been defined, we'll create that also and submit that to the staff for their, and then they'll provide that to ACRS.

So you'll have the entire picture of what we're planning to do right now. But as I would, I just, you know.

MEMBER ARMIJO: In that table, are you going to have a column on the size or size distribution?

MR. HEAD: Yes, yes. But then I probably won't do it, but they'll be a footnote or there could be a footnote that could say "subject to change as protocol evolves."

(Laughter.)

CHAIRMAN CORRADINI: Sure.

MR. HEAD: But that will be our current --

CHAIRMAN CORRADINI: I just think all the Committee is asking for is just a summary.

MR. HEAD: Okay.

DR. WALLIS: Could we get some real stuff from these Japanese containments? You said that there was sludge and rust and stuff in there. Could you actually provide some technical data about what that is like?

CHAIRMAN CORRADINI: To the extent they can, they will.

DR. WALLIS: Is it fibrous, what are the sizes?

MR. HEAD: Very little fiber.

MS. SCHLASEMAN: We have that information in the document, three-page document --

DR. WALLIS: You do have it?

MS. SCHLASEMAN: --that Maitri has, and we can send that to you. I think she has it.

CHAIRMAN CORRADINI: Okay, and then the last thing is, and I'll just repeat it, is that you've now pointed to a test protocol for the summaries in Appendix 6C, as is the defense indepth relative to the core flooder ~~flutter~~ and the bypass assembly. But there are RAIs that have calcs that we can look at, RAI responses on --

MR. HEAD: RAI responses with the calcs?

CHAIRMAN CORRADINI: No, no. I misspoke. RAI responses to those, both of those, the test protocol details, as well as the bypass assembly and core flooder ~~flutter~~.

MR. VAN HALTERN: I don't remember any RAI responses to the test protocol.

CHAIRMAN CORRADINI: I just want a place where I can look to see where you've done the estimate that these defense indepth measures will essentially keep you acceptable.

MR. VAN HALTERN: Yes. That's written up into the 6C.

CHAIRMAN CORRADINI: Okay.

MR. TOMKINS: But it's also summarized in some RAI responses.

MR. VAN HALTERN: Yes, a little more detail, I think, in the RAI.

MR. TOMKINS: So we'll get that to Maitri.

MR. VAN HALTERN: I'll get that Maitri through Tom.

MS. BANERJEE: Well 6C, your FSAR 6C we have.

MR. TOMKINS: I understand.

MR. HEAD: And the RAI responses you have, but I think he's looking for more detail in terms of the bypass discussion, which 6C doesn't got into all that.

MEMBER ARMIJO: Yes, we need the RAI responses.

MS. BANERJEE: Okay. So you are going to give me the more detailed RAIs?

MR. TOMKINS: I'll communicate to you and yes, I'll just give you --

MR. HEAD: Bill. I was going to say Bill might be --

MR. MOONHOEK: I don't think that information is in that level of detail in the RAI responses. I think most of those calcs were looked at in an audit, and there might be -- I don't know how much detail would be in the audit report.

But I think all that you will see in the RAI responses and in 6 Charlie will be the summary level.

CHAIRMAN CORRADINI: That's fine, and we'll go to the staff and ask about the audit report. That's not your call.

MR. MOONHOEK: Okay.

MR. HEAD: Well, I guess I'm -- I'm going to make a submittal that covers these first two. If I could make some sort of an attachment that says here's what's in these calcs that we did, which I'm sure will look ~~bio~~logical to you. We might consider doing that.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: You know what I mean? It's not, we can certainly still be proprietary, but we would -- you know, it would not be, I think, that difficult to describe what we did. So we'll consider that.

CHAIRMAN CORRADINI: Okay.

MS. BANERJEE: That's on the last question.

MR. HEAD: Yes, on this defense indepth, you know, some more understanding of our basis for that.

CHAIRMAN CORRADINI: All right, good.

MEMBER BANERJEE: Mike, I have a question.

Is it --

CHAIRMAN CORRADINI: You're still in under the grace period, but go ahead.

MEMBER BANERJEE: I was looking at all this stuff, and you know, I only attended the first meeting. There's a lot of discussion about zinc versus aluminum hydroxide, and I remember going to Germany once and looking at the effect of zinc, and they had these, you know, galvanized things and stuff.

It looked like the effect was pretty large. Is there sort of certainty that aluminum hydroxide actually covers what you expect with zinc? Have you looked at the German experience?

MS. SCHLASEMAN: No. I was just going to say the --

MEMBER BANERJEE: I know this has been visited before, but looking at all of your minutes and your notes and stuff, it struck me.

MS. SCHLASEMAN: The German document that you were talking about was specifically talking about galvanized steel, and we've specifically said that we will not use galvanized steel in the drywell, in the primary containment. So we're left only with inorganic zinc primer for our your coatings.

It's the base for the -- it's inorganic

zinc, primer, epoxy top coated, qualified coatings. So after the break, the postulated break and zone of influence, we're left with, I think, 47 pounds of inorganic zinc primer, which gets into the suppression pool.

We've done a corrosion calc analysis, PWR Owners Group that Tim Andreychek of Westinghouse did, and so it expands a bit. It's 58 pounds total zinc, and so that 58 pounds of zinc corrosion products, that's it. I mean that is all we have, and we had proposed, I guess this is where I should pass it over to Tim, but that was the link with the German paper, with galvanized steel.

MEMBER BANERJEE: The German, with galvanized steel or iron, eventually the zinc gets into some form of corrosion product.

CHAIRMAN CORRADINI: Right, but I think --

MEMBER BANERJEE: And I wonder if it does.

CHAIRMAN CORRADINI: But I think she's saying all of that's precluded. It's not going to be in the primary containment.

MEMBER BANERJEE: I know. How much is it?

MR. ANDREYCHEK: 48 would be --

MEMBER BANERJEE: No, yours is 48. How much is the German?

MR. ANDREYCHEK: Off the head, I don't

know. I can't give you a number exactly.

MEMBER BANERJEE: Ultimately, the zinc ends up as corrosion products.

MR. ANDREYCHEK: It does, and we predict that it does occur, and it occurs over a 15-day period, based on the data that we had, that chose corrosion rates. So at 15 days, and that's a conservatively short period of time.

So the way we ran the calculations, we assumed the size of the zinc, constituent in the inorganic zinc primer, stays the same. So it has a maximum surface area.

MEMBER BANERJEE: Can you just summarize for me the German experience with that?

MR. ANDREYCHEK: No, I can't. I don't have that German experience at my fingertips.

MEMBER BANERJEE: Because I actually told it was quite a large effect, they told me.

MR. ANDREYCHEK: A large effect. I don't understand what you mean by "has a large effect." If you could let me understand what it means.

MEMBER BANERJEE: Well, on clogging, you know, the chemical effects. I'd have to look at the report. It's been a long time ago.

MR. ANDREYCHEK: And I don't recall the

last time I looked at the German work, but our recollection was is that given what we were looking at, the aluminum hydroxide surrogate we're using gives us at least as bad if not worse pressure drop characteristics as the zinc products from the Germans.

And as a consequence, we chose to go with aluminum oxyhydroxide. Furthermore, even on the PWR side, you know, the amount of zinc compared to aluminum in PWRs was fairly small. Now we even assumed a relatively large amount of zinc for the corrosion product, and we're dealing now with something on the order of 47, 48 pounds, compared to hundreds of pounds in PWR. So it's really an order of magnitude lower, at least, what we think we have.

MEMBER BANERJEE: Do you have zinc treatment for radiation control?

MR. ANDREYCHEK: Zinc treatment. If you're talking about corrosion control in the plant, it's something that the plant is designed for. But it's not part of the current basis. So we don't have any more zinc, other than the inorganic zinc on the --

MEMBER BANERJEE: If you decided to use zinc, you'd have to go --

MR. ANDREYCHEK: Probably an evaluation under 5059, and we'd have to consider our previous commitments and the analysis that supports that. So if we need to change it, we would have to go through the regulatory process.

MR. HEAD: Maybe I can just summarize this. Maybe we can't give you the details of the German experience, but we certainly have reacted to it. We have done everything we can to minimize zinc in containment, and we believe we've conservatively modeled its impact on the downstream~~er~~ test. So we've been reacting to it for the last couple of years.

DR. WALLIS: I'd like to pick up on this. It's being said, Tim said it now, that aluminum oxyhydroxide had an enormous effect. It had an enormous effect in the ANL test. It shut down the whole thing, is what -- it just shut down the whole flow, became impermeable in that.

In the PWR ~~-- our~~ Owners Group tests, some of the tests you put in a huge amount of aluminum hydroxide according to the way it was specified to do it, and the pressure drop didn't rise at all, or it was very, very little.

So in those tests, those tests do not support the assertion that the aluminum hydroxide is so tremendous in its effect that nothing else could be so bad.

MR. ANDREYCHEK: May I respond?

DR. WALLIS: You certainly may.

MR. ANDREYCHEK: Thank you. I just want to make sure you're done, that's all, give you the courtesy of finishing. Those tests, and I don't disagree with you; you are correct. Those tests were tests where the --

CHAIRMAN CORRADINI: Which are those? Which those?

MR. ANDREYCHEK: The fuel tests, the PWR fuel debris capture tests.

DR. WALLIS: That we saw in May.

MR. ANDREYCHEK: That's correct. Many of those tests were under very high particulate to fiber ratios, and under those test conditions, based on what we observed and how we interpreted the data, the fiber bed was completely saturated with particulates. Bear with me please; let me finish.

And because you have an open lattice fuel assembly, which has gaps around the sides of the grid straps, we've had -- the fiber bed was fully saturated with both particulates, because the particulates couldn't be captured any more.

I mean we ran for a long period of time with the very high concentration of particulates, the silicon carbide, and the water was still cloudy. We weren't capturing any more silicon carbide.

Then the chemical product was added, and the fiber bed again being fully saturated, gave us almost no change in pressure drop, and in some cases it actually went down a little bit, because we think that we got bore holes and it worked our way through the fiber bed.

DR. WALLIS: You don't know why it went down, but it went down.

MR. ANDREYCHEK: Yes. We don't know exactly why, but it went down. The question is, the fiber bed couldn't take the pressure drop --

DR. WALLIS: So the aluminum hydroxide had no effect?

MR. ANDREYCHEK: However, to address your point directly, when we start getting into low particulate to fiber ratios, if we established a fiber bed and we started getting smaller amounts of particulate to fiber, we added the aluminum oxyhydroxide.

We did see an immediate increase in pressure drop because again, based on our observations and our interpretation of the data, then the fiber bed was not fully saturated. You began to collect more of this aluminum oxyhydroxide, and you've got a pressure drop.

DR. WALLIS: The pressure drop that you got when you added these chemicals, sometimes in a huge amount, was small. It was very small, compared with what has been found at Argonne, which was tens or more, so just shut down the whole loop.

You've got very small increments of pressure drop. So it's a myth that aluminum hydroxide always produces a very high pressure drop, and which is bigger than anything else you could produce.

MR. ANDREYCHEK: I'd take issue with that, from the standpoint of that it depends upon what you already have in the fiber bed. That's based on our experience.

DR. WALLIS: Yes, of course it does. Everything affects everything else.

MR. ANDREYCHEK: Right, and --

DR. WALLIS: But it does not produce a very high pressure drop.

MR. ANDREYCHEK: We have seen tests where we've had small amounts of fiber and particulate, we've added chemicals in it; it shut down our test also, because we did not have a fully saturated fiber bed.

As soon as you start getting chemicals on the fiber bed that's not saturated, we will get very high pressure drops.

DR. WALLIS: I don't understand your logic at all, that somehow putting the other particles in the fiber bed prevents the chemicals from having any effect.

MEMBER SHACK: Well, if the fiber bed is dead, essentially impervious, then making it more impervious --

(Simultaneous speaking.)

DR. WALLIS: The pressure drops modest even then.

MEMBER SHACK: But I think it's got enough openings.

CHAIRMAN CORRADINI: I guess, I'm listening to you guys go back and forth, and I think we have to let the staff come on. His interpretation is the reason is you've bypassed it.

MR. ANDREYCHEK: That's correct.

DR. WALLIS: Well Tim, you did a test where you measured the pressure drop when it's all bypass. None of your tests with chemicals ever approached that pressure drop.

MR. ANDREYCHEK: I'm sorry. So that one more time, please?

DR. WALLIS: You did tests where all the flow was bypassed. You actually blocked, blocked the fuel element and let the flow bypass, and you measured pressure drop versus flow rate. I've seen that test.

The flow or pressure drop there was much bigger than anything that was ever recorded on any of the tests. So you cannot say that the test reached the situation where everything was bypassed. We can go through this in a different meeting, but it's a myth, it's a myth that aluminum hydroxide always produces a huge pressure drop.

MEMBER BANERJEE: I guess that was the basis of my question. We go back to the original question. I'd like to really -- this will never be completely satisfactorily demonstrated to me, that now in the PWRs, of course, you have so much aluminum hydroxide compared to zinc. That's probably not a big problem.

But when you have many zinc and no aluminum hydroxide, is that using an aluminum hydroxide surrogate actually conservative compared to using zinc?

MR. ANDREYCHEK: The answer is that's, based on what we know today, that's what we're going to use. Now, that's not to say that the BWR Owners Group is doing other work, and they might look at something. We're going to follow what the industry says, and we'll take a look at the German test one more time, to see what it says.

But given that we don't have additional information, and there's no reason to suspect that there's anything else different, our experience, based on what we have available, is the aluminum hydroxide, oxyhydroxide, is the avatar that gives us potentially the worse pressure drop that we have seen.

MEMBER BANERJEE: So since these tests are going to be done some time in the distant future --

MR. ANDREYCHEK: Uh-huh.

MEMBER BANERJEE: Really what you're saying is that you have an undertaking that you will look at any other industry experience that might point to having a different surrogate.

MR. ANDREYCHEK: That's correct.

MEMBER BANERJEE: That's fair enough.

MR. HEAD: We've covered that in previous meetings. We covered it again here.

CHAIRMAN CORRADINI: You missed that part.

MR. HEAD: We committed to in our, on the docket and --

MEMBER BANERJEE: I was on a plane.

MEMBER ARMIJO: Okay. I just wanted to make sure I have it straight.

MR. HEAD: Sir, I'm sorry. Sir, did that answer your question?

MEMBER BANERJEE: Yes.

MR. HEAD: We really are going to stay involved with this. If something else comes up that's more of a challenge, as part of our submitting it to the NRC for their review, if we're still using aluminum hydroxide, and that's not the right, most challenging stuff at that point, clearly the staff would challenge us on it.

MEMBER BANERJEE: Well, I guess it depends on the taking you have with the NRC at the moment, that the test procedures and so on will be developed based on the best available knowledge.

MR. HEAD: It will be state of the art, based on our knowledge at that point in time.

CHAIRMAN CORRADINI: Okay.

MEMBER ARMIJO: In previous subcommittee meetings, I think I raised the question and other people raised similar questions on what form would -- what would happen with the zinc. The inorganic is basically metallic zinc in a carrier, and the question was could it form this kind of gelatinous oxyhydroxide, the same as aluminum? The question was we really don't know, but if it did, we're going to assume that it can. But it's more likely there will be zinc oxide particles, maybe even zinc metal particles, and some of it will even dissolve, not even in the actual solution.

So your alternatives are either to treat it as something that is, does have a big affect on pressure drop, as this gelatinous material, and that's what you've chosen to do. But you could also just test it as particulate. Also, you can address it by experiment.

MR. ANDREYCHEK: The other thing that we've looked, we started looking at the corrosion products. Again, this is for PWRs. We used equilibrium chemistry codes to determine what kind of products we would get.

Granted, they're not -- they're in thermodynamic equilibrium, so we're not looking at transience. What we saw was that the aluminum oxyhydroxides tended to be the dominant form. We also had sodium aluminum silicate and sodium, I'm sorry, calcium phosphate as products that came out, based on the constituents that were in PWR containments.

And so that was the direction we went in, and based on additional work that NRC funded, the aluminum oxyhydroxide appeared to be the worse case actor for the cases that were studied, and that's the direction we went in.

MEMBER ARMIJO: Okay.

MR. HEAD: Let me ask a previous question, though, that you asked, is that, you know, we don't have to wait until we run a test and go wow, that wasn't the right constituent. Between the time we get a COL, if the industry experience says hey, that's not the way to do something, we can always go back to the NRC and say we want to change, you know, our commitment and a more realistic test.

MEMBER ARMIJO: Yes. Instead of adding the zinc as the aluminum hydroxide, we'll add it as zinc oxide.

MR. HEAD: Yes. Future licensing managers are going to say who did that, but that was not the right thing to do, and we will want to approach NRC about a change. That would be a part of us using industry experience, as this thing evolves.

CHAIRMAN CORRADINI: Okay.

MR. HEAD: Okay.

DR. WALLIS: So back to the point I made before. The danger is that the industry adopts all these acceptable methods. Someone who does a realistic test and it turns out gives a bad result.

That reflects on the industry, NRC and everybody else, and someone has a quandary then. What are we going to do? When someone's done the more realistic test, and gee whiz, it's bad. That puts everyone in a very bad situation, including us. I don't want that to happen.

MR. HEAD: I agree.

CHAIRMAN CORRADINI: Okay.

MS. BANERJEE: But did I hear that you're going to come back with the German test, take a look --

MR. HEAD: No ma'am.

CHAIRMAN CORRADINI: No, no, don't do that.

MS. BANERJEE: So we're wrapped up in the industry test experience commitment.

MR. HEAD: Yes.

MEMBER ARMIJO: Does the staff have that information on the German test? Let's ask that question when they come up.

CHAIRMAN CORRADINI: Okay. With that, I'll thank NINA and Associates, and we'll turn to the staff.

MS. BANERJEE: Can we take a little break, so that I can go and check German --

CHAIRMAN CORRADINI: The what?

MS. BANERJEE: Dr. Corradini, Dr. Corradini. Can I go and check this, to see if I have the TEPCO stuff in here or not?

(Simultaneous speaking.)

CHAIRMAN CORRADINI: Sure. Can we do it after the fact? We don't need to do it right now. Let's do it after. Let's do it after. I want to make sure we get staff before we get too far behind.

(Simultaneous speaking.)

MR. TAI: Good morning. My name is Tom Tai. I'm the stand-in PA for Stacey Joseph, who's on maternity leave. But we are Jim Gilmer of Reactor System Branch and Greg Makar, who is the containment integrity and -- I mean containment and coordinate Mechanical and Engineering ~~Engine~~ Branch.

We are basically coming back in here to recap information that we reviewed and approved. So we do not have any new information since the last presentation. So if you have any new questions or old questions that you want us to revisit, that's why we're here, and then we have other reviewers in the audience that might help us. So Jim, with that.

MR. GILMER: Okay. Good morning. I'm Jim Gilmer. I happened to draw the short straw and presuming a long-term curve for the staff, that we have all of the appropriate reviewers to give more detail on any of the staff positions.

Most of the bullets you heard earlier from the Applicant this morning, so we apologize for any repeat. But feel free to stop me if you want further elaboration. Okay.

CHAIRMAN CORRADINI: I know where it is. I've got to see it, though. Here.

MR. GILMER: Thank you. Long-term core cooling for the STP ~~SCPA~~ BWR, as provided by RHR and the high pressure core ... ~~quadrant~~. RHR is pretty much a miniature of a BWR system. Long-term suppression pool cooling temperatures can be maintained by operating the RHR in suppression ~~core~~ pool cooling mode.

The analysis for containment pressure shows that it's well below the design value, and the analysis for core cooling, also has a large margin, because the vessel water level is always maintained above the top of the active fuel. Next slide.

The staff review approach is consistent with other reviews, both for the operating plants and for the advanced reactors. The basic review, I'm sure that the long-term cooling rule, which is 10 CFR 50.46, subsection (b)(5), is satisfied, and this review includes the evaluation of the strainer performance.

Downstream effects, I would add, that's both ex-vessel and in-vessel downstream effects, and then the chemical effects.

DR. WALLIS: When do we get to ask you about those last two?

MR. GILMER: On the ex-vessel and

in-vessel?

DR. WALLIS: No, no. About downstream effects and chemicals.

MR. GILMER: Oh, downstream effects. Well, I guess at any time.

DR. WALLIS: I read the FSAR, and it said there that the staff approved the use of these 10 micron silicon carbide particles as a surrogate.

MR. GILMER: I'll defer that one to Greg as our chemical expert.

DR. WALLIS: Well, my understanding from the PWR Owners Group test is that most of those particles simply went right through there, the fiberglass, and were not a proper simulant of particles which would be bigger or have different effect.

The chemical effects, you're not going to hear this just now, but aluminum hydroxide is cited as being the worst possible chemical, but then the two BWR Owners Group, as Tim Andreychek himself said, sometimes it had a beneficial effect.

So the assertion that it's always the worst possible would seem to be put into question.

MR. MAKAR: Just to correct what Tom talks about in terms of division of engineering, so I'm working on chemicals and coatings ~~codings~~ for some downstream ex-vessel effects. My understanding is a little different on a couple of things.

One, I'm not able to give a good summary now of what all that was done, but I know the NRR staff has looked, has spent a lot of time looking at how beds are developed and what happens to the particles, and my recollection is that they have seen a lot of particles trapped in the fibers, and they don't all -- those 10 micron silicon carbide particles or 10 micron particles of other materials that have been used don't all pass through. But sometimes they do.

DR. WALLIS: Well, if you make a prediction, if you actually do the calculation according to the methods that are standard on the pressure drop you would get if the particles filled the bed. If you'd get hundreds of psi. So something must be not quite consistent.

MR. MAKAR: I haven't done any of those calculations. I'm just talking about their observations in testing.

DR. WALLIS: I think the problem is that we're learning as we go along, and on an extraordinarily slow learning curve, about what happens with different mixtures of stuff in these beds. And as we learn, I think that the, that new evidence seems to put in question some of the old conclusions. Maybe I'll simply send you a memo, and you can study that.

MR. MAKAR: Well, we have some -- with chemicals, we have some of that learning built into this for following what's going on with the BWR Owners Group, and the staff, and I don't think the Applicant either. But just speaking for the staff, we didn't assert that it was the worst possible chemical. It's the worst that we know of and we have observed, where it has had a --

DR. WALLIS: It's the worst on some tests, such as the Argonne tests. Some had an enormous effect in a small amount. But then there's this new evidence from the Owners Group test that sometimes it has a beneficial effect.

MR. MAKAR: But in those tests we don't --

(Simultaneous speaking.)

DR. WALLIS: I would think that would be a red flag that's about as big as this building.

MR. MAKAR: Well, there's uncertainty, and if there had been another chemical for surrogate used in that test, whether it would have had a worst head loss than the aluminum oxyhydroxide.

DR. WALLIS: It's quite possible that I may deduce things one things one way and you guys may deduce another. You make a decision. I'm just going to tell you what I conclude from what I see.

MR. MAKAR: Right. But it's because of this uncertainty about the, about whether the zinc would actually form a precipitate, what form it would take, and how that precipitate would behave, that we number one went with the worst one we know of, and number two, had the expectation that the test plan will --

DR. WALLIS: But now you're not -- now it's put in question as to whether it is always the worst one, when you put --

MR. MAKAR: It's always been in question.

DR. WALLIS: --when you put in silicon carbide particles at 10 microns. It seems to have no effect at all. So it would seem that someone should actually investigate the reality and not guess. In fact --

MEMBER BANERJEE: well, we can separate two issues. One is the strainers and the other is downstream effects. In this case, if I understand it, we are requiring prototypical strainer tests for the PWRs, as you know. Every PWR has to do prototypical tests with the strainers, all operating plants, unless there's some extraordinary circumstance.

If I understand it, you're not requiring any prototypical tests here. You're going to take the experience from the German, I mean the Japanese ABWR test, right?

MR. MAKAR: And the BWR Owners Group, as well as the PWR.

MEMBER BANERJEE: Well, but the PWRs, every time you do something with an existing PWR, you've got to do a prototypical test, because no two PWRs -- I guess maybe that's too broad a statement, are still alike, you know, that you can take everything, you know.

We've been through this many, many times, the Reynolds numbers is that there are detailed differences. Since we can only depend on experiment, there is no theoretical basis, the NRR has adopted and we agree, a sort of set of proof testing, if you like, of each strainer concept, in prototypical conditions, with certain very clear guidelines as to how this should be done. It's to bound the sort of pressure losses.

Now maybe these tests that you're talking about are sufficiently applicable for the strainer, and there isn't that much debris in this system. Those are big strainers. So maybe as far as the strainer is concerned, you might be able to adopt it, and I presume you've looked at these previous tests and said they're sufficiently applicable, that we don't need to do any further testing. Is that the sort of position you've taken with the strainers?

MR. WAGAGE: Well, the debris strainers they are there to hold other particulates, you have to have fiber. There's only one cubic foot of fiber, that it's so much easier to strain it. So there, what --

MEMBER BANERJEE: That's the reason you haven't.

MR. WAGAGE: Yes. They have also done that we'll call the Japanese ABWR. They have done testing using a vertical loop, which has more fiber and even calcium silicate, and it was a vertical loop. All the debris settled on the strainer. They calculated the initial, the head loss.

MEMBER BANERJEE: It was the same CDI strainers that they used?

MR. WAGAGE: Yes. Now they had fewer pockets of the strainer for the testing. But they found that they had head loss. They used the same head loss. Also, they don't have any fiber in this case to hold the debris. So we did not have an issue with --

MEMBER BANERJEE: Using those tests.

MR. WAGAGE: --debris strainer head loss.

MEMBER BANERJEE: You basically accepted the Japanese test as being bounding? I'm just trying to understand the logic.

MR. WAGAGE: In this case, there is only one cubic foot of fiber to spread around so much. There's no way to argue so much head loss from the fiber and particulates, and the calculated head loss from RMI pieces by using (NUREG/CR-)6808 ~~68OE8~~ correlation, that gave us head loss.

So we did not have an issue with the debris strainer, because of there's minimum fiber monitor to give head loss, and also they use vertical test loop, which settle all the debris on the strainer. They calculated, measured head loss. They used the same head loss for this.

MEMBER BANERJEE: There was an issue, I'm just going back, because I haven't been here for the last four meetings. They kicked me off this Committee, okay.

There was an issue with void loss giving pressure waves, which for this particular type of strainer could put fairly large loads, and might be, you know, able to cause some problems that might allow RMI to go through. I sort of vaguely recall this, the sort of bubble collapse problem. Was that resolved, the pressure waves coming from that? Because these are very dense strainers.

DR. WALLIS: That was closed at one of our previous meetings.

CHAIRMAN CORRADINI: That was closed.

MEMBER BANERJEE: If somebody could tell me.

CHAIRMAN CORRADINI: The only thing -- so let me interject, just so we can move on. Everything, as far as I know, since I'm a new chairman for this Committee, everything has been closed, save for the pressure loss, save for the pressure loss versus flow rate testing, and the associated test protocol.

MEMBER BANERJEE: Okay. So this pressure wave business was closed.

CHAIRMAN CORRADINI: We, the royal "we," are okay.

DR. WALLIS: It was resolved in a rather peculiar way, by finding that the strainers behaved in a plastic way, and therefore they were okay. Now you mentioned something about --

CHAIRMAN CORRADINI: So before we go scattershot, you guys have about five or six slides. Why don't you, if you're done with strainers, let's move on, so we can get to what I think you're going to get as your myriad of questions, with your downstream effect. So let's stick with the program.

MR. GILMER: With the slide that's up now, I think pretty much we've, or the Applicant has covered this already. Now in-vessel effects, I'm sure there will be plenty of discussion on it.

The .95 void fraction, you heard earlier this morning, and staff reviewed the calculation by audit on several occasions, and we have reasonable assurance that the calculation is acceptable.

MS. BANERJEE: I have some more.

MR. GILMER: I believe you asked for the audit report. We can make that available.

DR. WALLIS: Now the audit report is about the GOBLIN calculation, the K?

MR. GILMER: Yes, correct.

DR. WALLIS: I will accept that. If it's about the way that the loop behaves, the downcomer and the pressure drop through the core. It provides the pressure drop available through the debris. If it's about the GOBLIN stuff, I will accept that. That's okay. That's fine.

MR. GILMER: Yes, it is.

DR. WALLIS: That's what you audited. You didn't audit the debris stuff?

MR. GILMER: I did not. Did you --

CHAIRMAN CORRADINI: We're only talking about, I think, the criterion by which we determined what is good and not good.

MR. GILMER: And I believe there were some documents.

DR. WALLIS: K is acceptable. The K for acceptability is all right by me.

MR. GILMER: And staff feels it's a conservative bounding.

DR. WALLIS: It's a standard thing.

MR. GILMER: The peak calculated temperature is well below the fuel melting temperature that's in 50.46.

You heard already about the diverse injection assertions of ECCS, and multiple pass for getting water into their core.

DR. WALLIS: Do they have a high probability of success?

MR. GILMER: We feel that they do. We've not done a PRA specifically for this.

MS. BANERJEE: You have to go through a few more pages.

DR. WALLIS: Because one way it's showing that the blockage doesn't matter would be to do a PRA for these other injection sources, and show that the, you know, that what's left over is negligible.

MR. GILMER: Maybe part of what's been done in their plant PRA, I'm not familiar with that. So I can ask them, but that's a good point. A key in the safety evaluation is that the fuel test that will be performed essentially 18 months before fuel is allowed to be loaded, must satisfactorily demonstrate that.

DR. WALLIS: So this is a no-go, this last one? I mean suppose they do get blockage? They have to then go back and do something else?

MR. GILMER: Yes, that's --

DR. WALLIS: That's still a no-go, even though diverse injection sources and all that stuff?

MR. GILMER: It would be a no-go for fuel load. There are multiple options at that point. You either reduce the debris source term or --

CHAIRMAN CORRADINI: Jim, can you just repeat that? You answered Graham, but I want to make sure I'm clear. So can you repeat that kind of from the beginning.

MR. GILMER: Well the fuel tests, which are essentially part of the license condition, will be no-go hold point for loading fuel, if they fail to meet the acceptance criteria. Then we'll have to stop and figure out what needs to be done.

CHAIRMAN CORRADINI: Okay. But what could be done is they can essentially use other analyses for their other what we were told to be, which is bypass flows and core flooder ~~flutter~~.

MR. GILMER: Yes. The GOBLIN analysis could be -- the conservatisms could be reduced. That's probably the cheapest option.

CHAIRMAN CORRADINI: Okay. Well, I don't care if it's cheap. I just want to know what the next step is, which is if they do these go/no-go tests based on these assumptions, and it turns out they don't pass, then they're going to have to deal with some sort of different analysis or testing.

MEMBER BLEY: Which would do the same thing, yes. It would show low impact on core flow. Yes, actual core flow, yes.

MR. GILMER: Or possibly even ECCS or fuel design changes. That's unlikely that they would --.

MEMBER ARMIJO: Okay, okay. I got it. I've got to get something on the record. This morning, the South Texas people reminded us of the March 2011 meeting, and from their Slide 15 they presented a defense indepth analysis, showing that high pressure core flooder ~~flutter~~ flow from above the core and fuel assembly bypass flow each, by itself, can provide adequate cooling for the core in the event the inlet to the hot assembly were to plug completely. That's pretty, a very strong statement.

DR. WALLIS: Yes.

MEMBER ARMIJO: My question is does the staff, has the staff reviewed or audited these analyses, and does the staff agree?

MR. GILMER: Yes, we have reviewed it, and we are satisfied this is the GOBLIN calculation that addresses --

MEMBER ARMIJO: Okay. So then if that's the case, whether the core blocks, whether it's 10 micron particulates or aluminum hydroxide, I mean basically Graham's question. If this is true, why does this test, to be done 18 months before fuel load, why is that even important? It's nice to do, but if these other things are reliable, why are we wasting time with all this stuff?

MR. McKIRGAN: If I could, this is John McKirgan from the staff.

MEMBER ARMIJO: Please do.

MR. McKIRGAN: In this instance we're looking at, this is really a licensing issue, and we're establishing the licensing basis of the plant. These other mechanisms are valuable information; they provide defense indepth and the staff is very comfortable with them.

But the licensing basis of the plant must be satisfied before they can load fuel. The Applicant has proposed and the staff is on the verge of accepting the fact that this license condition and the curve is what is establishing the licensing basis, and absent that, they will not be allowed to load fuel.

MEMBER ARMIJO: Why isn't the licensing basis core coolability --

CHAIRMAN CORRADINI: That's their choice, though. That's the licensee's choice.

MEMBER ARMIJO: Okay. So they're taking a risk.

CHAIRMAN CORRADINI: Well, they've made a decision. They may have to change their decision, but they've made a decision currently.

MR. McKIRGAN: And we've discussed, and as Jim and the Applicant have both said, should they fail, there are options, all of which would have to come back to the staff for review.

MEMBER ARMIJO: Okay.

MR. GILMER: And essentially, it would amount to a delay in the initial start-up.

MEMBER ARMIJO: Yep.

MR. GILMER: And then --

MEMBER BANERJEE: How many months before the loading would these tests be done?

CHAIRMAN CORRADINI: 18 months.

MR. GILMER: 18 months, and we will see the test protocol essentially 24 months before they --.

~~MS. BANERJEE: I made a copy.~~

MR. GILMER: Okay. Regarding conservatisms in the ABWR design and the STP-specific analyses, some of these you heard already. The first is the reduced likelihood of latent debris generation. The reasons, in parenthesis, the restricted access to containment by administrative procedure. The suppression pool clean-up system and of course the stainless steel suppression pool, and the operational program for --

MEMBER BANERJEE: Do you agree that for these tests, latent debris should be all considered essentially NUKON, rather than hair and stuff like that? I mean we had an issue with this, with another advanced plant, where they did some experiments with hair.

MR. WAGAGE: Actually, we did that in a past meeting, the same, communicated the same issue and we brought up the results for testing for the other advanced plant. What we showed was that other types of like human hair and clothing did not matter.

MEMBER BANERJEE: It did.

MR. WAGAGE: It did, but this was -- what happened with fiber was that you got earlier, but you got breakthroughs. With the hair, it continued to rise, and it went on and on and on.

MEMBER BANERJEE: So the characteristics were different. You did not get breakthroughs, you know, in the downstream effect, the in-vessel effects. I can show you the graphs.

MR. WAGAGE: But I compared the peak --

MEMBER BANERJEE: The peak was comparable, but the characteristics were very different and, you know, it depends on the type of fuel, because this is a classically ill-posed problem. If you get a slight change in conditions, you can get a big change in results.

But to make assurance, doubly-sure, I think you should probably look at a couple of experiments with hair, just you know.

DR. WALLIS: Well, Sanjoy, earlier we were told in the Japanese plants, they found ropes and things like that. There was no fiber in this plant. So modeling with fiber is a surrogate. What has been found is ropes, which are made of something else. But you don't have fiberglass ropes, as far as I know. So maybe you should look at that.

MEMBER BANERJEE: Well, the issue we had

before was that if you had cloth and stuff, it would not maybe degenerate to fibrous form that quickly. So the main latent debris would probably be, you know, fluff and hair and other stuff like that. But I mean --. But you know, with the previous thing, that was okay. I mean we had no issues ultimately. We agreed to whatever was presented. So but they did run a couple of experiments.

MS. BANERJEE: This is what they --.

MEMBER BANERJEE: Yes.

MS. BANERJEE: They had different kinds of tests.

CHAIRMAN CORRADINI: Keep on going.

MEMBER BANERJEE: Yes, I'm happy. Go ahead.

MR. GILMER: Okay. The next one is a key advantage for ABWR over conventional BWRs is the elimination of the large --

DR. WALLIS: I wanted to ask a question about this one cubic foot. I think if I were South Texas, and I were to come in and say there's no fiber, therefore there's no fiber, a supposition. For some reason, someone dreamed up this one cubic foot. Did that come from you folks or from them?

MR. GILMER: The original position, I believe, was no fiber.

DR. WALLIS: Why was that not acceptable?

MR. GILMER: Well, I think that came from our first meeting with the ACRS.

MR. WAGAGE: Actually, originally these approved BWR had so much fiber, and South Texas came up with their design, and they removed all the fiber, and they came up and said that we have zero fiber in the containment.

And we asked the question: What happen if you find some fiber in the containment later on? Then you are outside the licensing basis, and that would be a major issue. To avoid that major issue, they assumed one cubic foot of fiber to consider any amount of fiber they might find.

But they have containment clean-up, cleaning program --

DR. WALLIS: But why was it one and not two, or a half or .1 or something else?

MR. WAGAGE: Actually, the question might come. Even if they assume two, then we might have a question why not three?

(Laughter.)

DR. WALLIS: Well, it may well be. It may well be.

(Simultaneous speaking.)

DR. WALLIS: But three is bad.

MR. WAGAGE: The issue was that they did not have any fiber, but when they raised the question that how do you have any licensing issues later on, they assumed one could be good for fiber. We tested to our latent fiber --

MEMBER BANERJEE: That is latent fiber, isn't it? Is that latent fiber?

MR. WAGAGE: Yes, this is latent fiber, yes. Latent fiber --

MEMBER BANERJEE: That doesn't seem unreasonable.

MR. GILMER: So thank you.

(Laughter.)

CHAIRMAN CORRADINI: What is the "that"? The that that is zero, or that that is one?

MEMBER BROWN: One cubic foot.

MEMBER BANERJEE: I mean what is the experience in those Los Alamos swabs and all that? Do you remember?

MR. WAGAGE: You see, they had their different amount of fiber because for URG calculations, because they assumed the containment --

MEMBER BANERJEE: The latent, you know, those experiments that were done for latent fiber, remember? It wasn't a particularly clean containment, but I'm trying to recall. Wasn't it --

DR. WALLIS: PWR?

MEMBER BANERJEE: Yes.

DR. WALLIS: In the PWR?

MEMBER BANERJEE: Yes, the PWRs, not BWRs.

MR. WAGAGE: Yes. I don't remember exact number. They assumed certain number on the fiber. But this containment is different, this has --

DR. WALLIS: Much smaller.

MR. WAGAGE: Smaller and containment cleanliness program. It has suppression pool cleanliness program. It has control of many fibers getting into the containment.

MEMBER BLEY: I seem to remember at an earlier meeting, it might not have been for this plant, that somebody on staff brought in a set of reports of inspections of containments, in which transient materials were found after the containment had been cleared, and used that as something of a basis for the thing. Do you guys remember that?

CHAIRMAN CORRADINI: But I think --

MEMBER BANERJEE: Those were PWRs.

CHAIRMAN CORRADINI: So let's just, let's just back up. I want to make sure we stay on track. Before you were here, we had this discussion with the

STP folks.

MEMBER BANERJEE: Why do you ask me to come?

CHAIRMAN CORRADINI: Well, we anticipated your arrival with great expectation, but we proceeded anyway, and when STP discussed this, there was actual experience from KNK 6 and 7, where they've actually collected and analyzed what's there. That's what Graham referred to.

So we're going to get a document. One of the things that we agreed to from STP is we're going to get a summary document of what was seen there as the technical basis for the one, what would make up the one cubic foot.

MEMBER BANERJEE: Fair enough.

MR. GILMER: Okay.

DR. WALLIS: Well, I would just recall, Dick Skillman is not here. When he was here, he said that he actually ran reactors, that they found sawdust, for instance, in containment. Someone had cut something when they were doing something, and there was the sawdust.

CHAIRMAN CORRADINI: That's the Navy built. That isn't our experience.

DR. WALLIS: No, no, no. It was Texas.

(Simultaneous speaking.)

MEMBER BLEY: It's either a commercial ship or a commercial plant. That's where he's at.

DR. WALLIS: Well, the one cubic foot seems a little suspicious. If they'd been Europeans that have said .1 cubic meter or something, you know. It's just a number, and we asked this morning that they be more justifiable, that there be more justification for it, because just one looks like something, you know.

MEMBER BANERJEE: Well, it's probably .1, but they put it --

DR. WALLIS: If you can justify that it's never been measured above .1 and it's no longer, that would be --

MEMBER SHACK: Well, it just puts them at risk. If they find more than one, they're going to have a problem.

MEMBER STETKAR: That's right. That's all it is.

DR. WALLIS: That's all it is?

MEMBER STETKAR: They've shown that they can live with one. If they ever find more than one, they have a big problem in the licensing world.

DR. WALLIS: This more than is a real question, because BWR Owners Group test, it turned out that more particles was better. More particles produced less flow, less pressure drop.

(Simultaneous speaking.)

MEMBER BANERJEE: But you know, if you really look at this, one cubic foot comes out to be a couple of grams for assembly.

DR. WALLIS: Something like seven grams for assembly or something like that.

MEMBER BANERJEE: Is it as much as seven?

DR. WALLIS: I'm thinking it's less than that, less than that. It's a very, very --

MEMBER BANERJEE: Yes.

MR. WAGAGE: About one.

MEMBER BANERJEE: So I mean I think they are quite far away from any boundaries, and they could probably relax this, and say you can have three.

CHAIRMAN CORRADINI: But I don't think we should tell -- I mean --

MEMBER BANERJEE: That's up to them.

CHAIRMAN CORRADINI: That's up to them.

MEMBER SHACK: We're not designing a licensing argument for them.

CHAIRMAN CORRADINI: No. That's their job.

MEMBER BANERJEE: A lot of conservatism there, yes. That's all I'm saying.

CHAIRMAN CORRADINI: It's their strategy. They have to own it, not ours.

MR. GILMER: As I started saying, ABWR has a big advantage over operating BWRs, in that the large recirculation piping is eliminated by having internal pumps. Also by design, there are no breaks, or all breaks are above the top of the active fuel, so the core remains covered.

All corroded aluminum and zinc is assumed to precipitate in gelatinous form, and there are ABWR design features that minimize the transport of actual and generated debris. By that I mean like RHR takes a suction ~~section~~ from the suppression pool, which is a closed volume.

There are a couple of very torturous paths for like a steamline breakthrough that would require some flooding or cascading or gravity would get it into the suppression pool. The diversity of ECCS delivery locations, the various water systems and water sources, and most of those sources are also closed for core flooder ~~flutter~~, high pressure core flooder ~~clutter~~ tank.

~~Clutter~~ Flooder tank and piping, and you heard already many times about the factor for conservatism built into the GOBLIN analysis.

CHAIRMAN CORRADINI: So let me ask a question here, and I'm not sure if I'm ahead of you in the slide. So if it's later, you can just postpone it. I think the question we ended up with STP was that we wanted to learn enough about the test protocol that we were comfortable with, to the extent that we understand what the limit is and how the limits folds into a line, and the line is decreased by a factor of four because of this and that.

What I think we were left with is we wanted to make sure the test protocol was acceptable, and detailed enough that you found it acceptable. So my question is what are the elements of the test protocol that were key to you that you found it acceptable?

Because I sense that Dr. Wallis is still unclear. So what made it clear for you, because I think in some sense we're still ruminating about the test protocol. That's why we're asking to look at some additional documents.

What were the sufficient conditions that allowed you to say that this was a good test protocol going forward at this point?

MR. GILMER: From my perspective on downstream --

CHAIRMAN CORRADINI: And if not now, if you have it in a later slide, that's fine. But I just wanted to make sure we cover that.

MR. GILMER: All right. We can talk about it now. The GOBLIN calculation, I think used a natural circulation flow rate of about three feet per second, or a velocity of three feet per second, and that test protocol does essentially start with that.

DR. WALLIS: Three feet per second.

MR. GILMER: I'm trying to remember from two years ago, so I may be wrong. But Westinghouse can correct me, but that's my recollection.

MEMBER BANERJEE: It is a flat temperature limitation, like 800 degrees or something that they're trying to meet, or is it a quality criteria? What is the real thing there?

MR. GILMER: Well, the long-term cooling ~~fueling~~ regulation is related to the --

DR. WALLIS: The velocity in the PWR test is .2 feet per second. I think you are thinking about three gallons per minute or something like that.

MR. GILMER: I could be wrong on that.

MEMBER BANERJEE: But usually there is a criteria they're trying to meet, right?

DR. WALLIS: In the PWR, it's something like 304 gallons per minute per assembly. It's gallons per minute, the way they express it, and it turns out to be I think about 0.2 feet per second.

MEMBER BANERJEE: It sounds reasonable, but that meets some criteria in terms of clad temperature, right?

DR. WALLIS: Boiloff.

MEMBER BANERJEE: 800 degrees? What is that?

DR. WALLIS: Boiloff, I think, is the --

MEMBER BANERJEE: No. It's --

MEMBER SHACK: In terms of quality, they were going to go from 0.95.

MEMBER BANERJEE: No. Before the APWR or whatever -- not the APWR; AP-1000, if I can say the word, we ended up with an outlet quality criteria which translated back to all sorts of things, right?

DR. WALLIS: And it started off as boiloff, and then it got backpacked to 0.95 quality or something.

MEMBER BANERJEE: 0.5, 0.5 quality, I think. 0.95 void fraction.

So that was -- and that backed out to some clad temperature lack of wherever. So here, that's the question. Is it something equivalent to that that you're trying to achieve by these criteria?

I mean then you can back out the pressure loss, which gives you this quality, you know, or if it can be traced back, and then the available head, wherever this pressure loss, should give you the slope. I'm just wondering how you establish it?

MR. GILMER: To some degree, it's part of the thermal properties of the crud buildup on the fuel rods, but I believe --

MR. MAKAR: Part of their in-vessel analysis is looking at the effect on peak clad temperature of depositing all of the debris that we discussed for this plant, including chemicals, on the fuel and seeing the physical dimensions of that and the temperature. That's part of the --

MEMBER BANERJEE: Yes, but part must also be that you don't want dryout, extended periods of dryout, right? So you have to have a certain quality.

CHAIRMAN CORRADINI: But that's why -- just to interject. That's why they've picked .95 as the void fraction. That is way below the point of dryout. So I mean --

MEMBER BANERJEE: Well, they must have justified that in some way.

CHAIRMAN CORRADINI: But I think my answer, as you asked the question, the step I answer back is they back out essentially what you're asking for, is given

.95, there's some sort of, with some margin, a bound to dryout. They look at essentially the flow rate that allows that.

MEMBER BANERJEE: It seems quite reasonable. But what I'm saying is have the staff looked at that, and agreed that this is an appropriate criteria, that whatever the outlet quality or void fraction is will guarantee that the fuel, you know, stays, if it's exposed for a long time to temperatures, which I don't know what they are. Is it 800 degrees? What is the temperature you're shooting for, for long-term dryout situation?

MR. MAKAR: I don't know what this Applicant used as a criteria for an upper temperature, but I don't think that was the main criteria for long-term cooling.

MR. GILMER: No, because it was well below even the 800. So we were not concerned.

MEMBER BANERJEE: So you just said we don't want dryout? What was the --

CHAIRMAN CORRADINI: I think they said .95 was acceptable.

MEMBER BANERJEE: Huh?

CHAIRMAN CORRADINI: I think all they said was .95 is acceptable.

MEMBER BANERJEE: But why?

CHAIRMAN CORRADINI: It's way below -- I'm not going to answer for them. I'm sorry.

MR. McKIRGAN: Could you go back one slide please, Tom? Could you go back to a previous slide for us? It's Slide 5. So Jim, perhaps maybe we went too quickly through this slide. But the first bullet there talks about the .95 void fraction. The next bullet talks about staying below the criteria of 50.46.

MEMBER BANERJEE: Yes, okay. But that is really -- and what is that? Can you remind me that criteria, 50.46? Is it 800?

CHAIRMAN CORRADINI: It's a 2,200 number.

MEMBER BANERJEE: It's a 2,200 number?

CHAIRMAN CORRADINI: Yes. They're nowhere close to it.

MEMBER BANERJEE: No, no. But that's not what other applicants have used.

MR. McKIRGAN: No. But I think we need to be mindful again, this is Jim McKirgan for the staff. Everyone is introducing significant conservatisms, to make sure they maintain margin for operability considerations.

So we will see a range of temperatures from a number of applicants, all of which have to stay, of course, below the regulation of 2,200. So I don't recall and I don't know if the staff has exactly what this applicant is using, but they are all well removed from the limit.

MEMBER BANERJEE: Okay. So I mean 2,200, of course, is way high. But most applicants that I'm familiar with have, you know, for a prolonged exposure, they've accepted a much lower temperature, and but they're shooting for a much lower temperature.

That leads to a criteria like that .95, which may be equivalent to 50 percent quality or 30 percent quality. I don't know; whatever that number is.

DR. WALLIS: I thought it was 800 degrees Fahrenheit.

MEMBER BANERJEE: It's usually 100 degrees. That's what they shoot for. I mean --

CHAIRMAN CORRADINI: So I want to make sure we're on track. So are you asking the staff what was their basis to accept the .95, or are you asking STP?

MEMBER BANERJEE: I'm asking the staff why did they accept that?

MR. GILMER: Well, we'll look at the 2,200 in the regulation.

MEMBER BANERJEE: That's very unusual. I mean for this long-term cooling, you accept 2,200 forever as the criteria?

MR. GILMER: Well, only because they were substantially below that, basically saturation.

MEMBER BANERJEE: Yes. But in previous, if you look back, in previous NRR or maybe even NRO, I thought that number was around 800.

MR. MAKAR: This, for the analysis that this applicant did for that issue, the temperature rise from depositing the material on tubes, I don't know what their criteria is. I can tell you it was a small incremental increase, and I don't know if it's proprietary for us to discuss the specific temperatures.

MEMBER BANERJEE: Oh, this is not closed at the moment?

CHAIRMAN CORRADINI: No.

MR. MAKAR: But they did an analysis like that, and it's much less than --

MEMBER BANERJEE: Yes, because the case that I'm talking about is very different from this case, because there is issues with boron depositions and all that that occur, and that's what limits the outlet quality. So maybe we can't speak of it freely here, but that's the reason.

MR. MAKAR: I don't have, from my area, a good understanding of that, the relationship between that analysis of the deposition of the materials on the fuel and the temperature and --

MEMBER BANERJEE: Which is what limited the outlet quality. But it leads to a void fraction probably close to this or even higher than this. This could be just as limiting. So this is dictated by deposition on the fuel, this .95, or how did it come about?

MR. GILMER: Well, kind of indirectly, the thermal properties of the crud is included in the GOBLIN model. So it's being accounted for in the calculation.

MEMBER BANERJEE: So this is a prediction from GOBLIN, that you need to stay below .95?

MR. GILMER: Right.

MEMBER BANERJEE: And then your fuel remains at whatever temperature.

CHAIRMAN CORRADINI: Far below 2,200.

MEMBER BANERJEE: Far below.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: Okay, let's move on.

DR. WALLIS: Can I ask you about the debris? We have a table here of 195 pounds of sludge, 150 pounds of dirt and so on. I think in the PWR Owners Group test, all this stuff was represented by 10 micron silicon carbide.

Now I've gathered from the FSAR, that you guys were going to -- it says here that you were going to accept this silicon carbide as the surrogate for all the debris. Is that still your position?

MR. MAKAR: It's not all the debris. It's all the particulate --

DR. WALLIS: All the particulate debris is modeled as silicon carbide with 10 microns?

I really question that surrogate being used in this way. I think the properties are just, of the real debris is quite different. It will interact differently with the fiberglass, and it would act differently with the chemicals.

I think it's being accepted by some sort of historical precedent, that someone at some time in the remote past proposed this, and it wasn't really questioned. But then it looks, from my end anyway, looking at the BWR Owners Group data, as if it should be questioned.

So I'm questioning it, and then asking the staff to look closely at it.

CHAIRMAN CORRADINI: Does the staff have any comment back to Graham?

MR. MAKAR: Well, I'll speak and Henry, if you want to add anything, please do. But yes, it's -- I would say we're trying to be consistent with staff guidance on what's been accepted previously. You're right about that.

DR. WALLIS: It's an EPRI recommendation. The staff accepted it, and assuming it was conservative to use small particles, without thinking perhaps that small particles have an easier time going through the fiberglass than big particles, and there may be that new evidence needs to be considered in accepting this.

So I'm just asking you to do that before the 18 month test gets started.

MEMBER ARMIJO: Well, that's a generic question, right?

DR. WALLIS: Well I know --

MEMBER ARMIJO: And that's not -- I think it will be looked at continually.

DR. WALLIS: Well, it's more frightening, perhaps, than the South Texas one.

CHAIRMAN CORRADINI: Well I mean Graham, I guess I'm kind of with Sam on this. What you're asking here kind of in some sense transcends STP. You're concerned about the use of surrogates generally, not just here.

DR. WALLIS: Yes, but in this context, it makes sense, because they have given us these large numbers of debris, which are not silicon carbide particles.

MEMBER SHACK: Yes. I think one of the differences here is that they won't have much of a bed. There won't be much filtering. I mean you can make an argument in other cases, larger particles are likely to be filtered by the bed here.

CHAIRMAN CORRADINI: Filtered by the bed.

MEMBER SHACK: All of it, yes.

CHAIRMAN CORRADINI: On the strainer, you know. Filtered by the strainers themselves.

MEMBER SHACK: Filtered by the strainers. I mean here, everything is going to --

MEMBER ARMIJO: Go right through.

MEMBER SHACK: Come through. You know, there's not --

MEMBER BANERJEE: The fact is except to keep the RMI out, the strainer is not going to stop the fiber.

CHAIRMAN CORRADINI: That's true, but that's what they've assumed.

DR. WALLIS: They assume it all gets through?

CHAIRMAN CORRADINI: Right. So I'm struggling as to what, what are you asking the staff?

Your comment is you're concerned about the use of surrogates. But are you asking the staff to --

DR. WALLIS: But I'm specifically bothered by replacing all of the stuff. For instance, the sludge which I say, and rust was known to produce unexpected effects at Barseback, with silicon carbide, very small particles, which have different physical properties altogether. It seems as if in the Owners Group test, a lot of them simply went right through the fiberglass without being stopped at all.

MR. MAKAR: Well, we do have to use a surrogate. I mean it would be smart to use the rust sludge, but it can't be done. The material doesn't exist and may never. We don't know what we'll find when --

DR. WALLIS: Doesn't it exist in some type of --

MEMBER ARMIJO: Greg, you can make iron oxide real easy. Reactors do it every day.

MR. MAKAR: It may be under different, slightly different water chemistry. Is it -- does it have exactly the same properties as what they will really find?

MEMBER ARMIJO: I think its properties are better, more representative than silicon carbide, even if it's a bad iron oxide, you know. It just seems to me that you try to be as prototypic as you can.

DR. WALLIS: I disagree with you entirely. You say it can't be done. There must be a basis for saying there is sludge there and there is dust there. So someone must have found sludge there, someone must have found dust there. Take that stuff and use it.

MR. MAKAR: And the rusty sludge is really, it is like a -- it's particles mixed with a lot of water. It's like when you take sand at the right consistency. You pick it up and it flows like --

DR. WALLIS: You have it, you have it. You don't need much of it for one assembly. I disagree with your statement you cannot use the right stuff.

MEMBER SHACK: Well, you certainly can use a distribution of sizes of particles, whether they're silicon carbide or not.

MR. MAKAR: Yes, yes, and we can --

DR. WALLIS: Yes. But it introduces a whole lot of new problems when you use a surrogate, and the fact that you know it's there means that it's there, and you can pick it up and use it.

MEMBER BANERJEE: How did we arrive -- Bill, do you remember, at silicon carbide as a surrogate?

MEMBER SHACK: I think --

MEMBER BANERJEE: There's a long history.

CHAIRMAN CORRADINI: I'll let the staff give their shot.

MEMBER BANERJEE: Yes.

MR. MAKAR: Well, it's not the only surrogate that's been accepted.

CHAIRMAN CORRADINI: Walnut dust.

MR. MAKAR: Walnut dust, tin powder, acrylic powders. It depends on the -- some licensees have used acrylic powders for coatings. Some have used other small particles, and the size range was just taking coatings, for example, looking at what's the range of chip sizes and what's the range of particles, the smallest constituents of that coating.

It's a little different for epoxies and inorganic things. So the staff has looked at the different materials and what different sizes they are, and what would be acceptable as a surrogate. So silicon carbide was one of the materials that, as Professor Wallis said, years ago that the staff --

MEMBER SHACK: You know, it doesn't dissolve and it's readily obtainable in a wide variety of sizes.

MEMBER ARMIJO: And it's inert, inert in that environment, right? So the particle sizes stay the same.

MEMBER SHACK: But I think what the SC on the NEI document actually says is that you can use, the fine particles are assumed to be conservative if you have a fibrous bed. If you don't, then you're on a plant-specific basis, supposed to justify your choice of particles. Here, you could make the argument that they would have to do some sort of a justification of particle size at least, and particle characteristic.

DR. WALLIS: Well, rust flakes. I mean flakes presumably are not round things. They're more likely to get stuck, probably.

(Simultaneous speaking.)

CHAIRMAN CORRADINI: Other comments?

MEMBER BANERJEE: Your concern is with the in-vessel test.

CHAIRMAN CORRADINI: His concern is with what we're going to get as a summary of what will be the actual materials and inventories and sizes, and those that they choose to have surrogates, the justification for the surrogates. Not just inventory, but size distribution and surrogate composition.

MEMBER BANERJEE: For the in-vessel.

CHAIRMAN CORRADINI: For the in-vessel.

MEMBER BANERJEE: You're not worried about the strainers.

CHAIRMAN CORRADINI: Nope, nope.

MEMBER BANERJEE: Or are you worried about the strainers?

DR. WALLIS: Those strainers are no longer part of the conversation.

CHAIRMAN CORRADINI: Were not part of the -- we're talking about downstream effects.

MEMBER BANERJEE: Downstream effects, all right.

MR. MAKAR: Right, and I would like to just, for the record, be clear that yes, we were looking at surrogate materials, to try to be -- we were, yes. We were accepting surrogate materials on ones that were consistent with existing staff guidance, rather than looking for real materials instead of surrogates. That is correct.

MEMBER BANERJEE: I guess the problem is that we haven't really done a lot on downstream effects in BWRs yet. We've looked at the BWRs, and we understand what's going on a little bit. But the materials are somewhat different.

As long as the idea is that whatever we learn, frankly incorporate into these tests, which will be happening some time in the future, that seems reasonable, because we're going to have some testing for that, right?

CHAIRMAN CORRADINI: Other questions for the staff on this?

MR. GILMER: Okay. This next slide is an attempt to refresh your memory. As you heard previously, also for the benefit of the members that have not heard before, there is in the safety evaluation for FSAR Appendix 6C, a license condition that the staff felt it was needed, because well first, the STP COLA, the COL application, essentially incorporates the certified design by reference, that there are --

Well, there's one significant departure is the casset-type strainer, as opposed to the stacked disk conventional GE strainer design. So essentially then we had to address the GSI-191 because of that departure.

This license condition is intended to ensure that whatever fuel is loaded will perform satisfactorily with debris blockage. I should say that that blockage was never considered in the original certification, because the issue did not emerge for BWRs at the time of certification.

The proposed license condition includes test acceptance criteria, which you've heard already, that must be met for any type of fuel that's going to be loaded for --

DR. WALLIS: When is this likely to happen? I mean we've got two years here. We've got six months prior to testing and then 18 months prior to load. When is load expected to happen?

CHAIRMAN CORRADINI: That's undetermined.

MR. GILMER: Yes, currently undetermined.

DR. WALLIS: Well if it's in three years, then we don't have much time to --

CHAIRMAN CORRADINI: It's undetermined.

MR. GILMER: For other reasons, it's undetermined.

DR. WALLIS: So it's not something that's around the corner?

CHAIRMAN CORRADINI: No.

MS. BANERJEE: Definitely not.

DR. WALLIS: So we can keep on not knowing much about debris for a few more years.

CHAIRMAN CORRADINI: The evolution may take -- there will be evolution in other fields faster.

MR. GILMER: I'm sure the Applicant hopes it will be this decade.

MEMBER ARMIJO: With this license condition, let's say the initial core fuel is put in there; it's tested. It meets the acceptance criteria.

Then they want to put in a reload of a different fuel design. Would this license condition require them to repeat those tests?

MR. GILMER: Yes.

MEMBER ARMIJO: And meet the acceptance criteria of those tests. So they are forever more having to repeat those tests. Even --

CHAIRMAN CORRADINI: Well, let me just generalize it though, because I think Sam's point is correct. But that would be the case for any of the plants.

MEMBER ARMIJO: They'd have to pass a test?

CHAIRMAN CORRADINI: If they have a different fuel type, they will have to show long-term cooling capabilities. This is not just specific to the ABWR. The AP-1000, if they change the fuel type, they'd have to redo it.

MEMBER ARMIJO: Strange licensing conditions.

CHAIRMAN CORRADINI: The ESBWR, they'd have to do it. That's my interpretation, as I understand the --

MR. GILMER: And the staff agrees with that. We'd expect submittal of a topical report that would address this issue.

MEMBER ARMIJO: Well, submitting a topical report is one thing. But having to do an acceptance test over and over and over, using unrealistic surrogates, using artificial conservatisms. It seems to me it's not performance-based. It's certainly not risk-informed, and it's just strange.

MS. BANERJEE: Can I add something? Didn't the Applicant commit to doing this, the analysis that they're going to send to you 24 months in advance, with the fuel that they're going to be loading in the first batch?

MR. GILMER: That's correct, and we've already received some of the topical reports, which I believe ACRS wants to have presentations on in the future.

MR. McKIRGAN: But Jim, if I could clarify. Those actions are not part of the current licensing action, what we're doing now.

MR. GILMER: That's correct.

MR. McKIRGAN: SER does not speak to this.

CHAIRMAN CORRADINI: This is different?

MR. McKIRGAN: That is a different licensing action that the Committee will have an opportunity to engage on.

CHAIRMAN CORRADINI: Okay.

MR. GILMER: That's correct. That's basically to stay ahead of the game, on the schedule.

CHAIRMAN CORRADINI: Right, okay.

MR. GILMER: The two commitments that are now in the FSAR, you heard previously about the order kind of doesn't make sense now, because the first Commitment 61 was there in earlier revisions of the FSAR, and the second one was added, after discussion with staff, that we want to see the test protocol before the tests are started.

So it would make more sense to have them written in reverse order. But the current revision leave just the way it is. Okay. Next slide.

MEMBER BANERJEE: Are there any downstream effects tests being planned for the BWR Owners Group that you know of?

MR. GILMER: I believe the tests start in 2013. Correct me if I'm wrong, Greg.

MR. GILMER: 2013-2014 time frame, and the proposed fuel for STP is one of the fuels that will be in that test area.

Okay. So in summary, the staff has reasonable assurance that adequate core cooling can be maintained, to meet long-term cooling requirements, and the containment pressure and temperature are maintained below design value, and STP therefore meets 10 CFR 50.46, subsection (b)(5).

DR. WALLIS: If you have this conclusion, why do you need any tests?

MEMBER BANERJEE: Subject to --

(Simultaneous speaking.)

MR. GILMER: There should be an asterisk. Subject to --

CHAIRMAN CORRADINI: It's subject to satisfactory performance of the tests.

MEMBER BANERJEE: Subject to the conditions, license conditions being met.

CHAIRMAN CORRADINI: Yes.

MR. GILMER: Any other questions or discussion?

CHAIRMAN CORRADINI: So let me -- two things for the Committee. So one, I want to make sure we get public comment, time for public comment, and two, there is another subcommittee meeting starting in this room in 50 minutes. So --

MEMBER BANERJEE: Which one is that?

CHAIRMAN CORRADINI: Well, that chairman will talk to you about that. But I just want to make sure of the time frame. So first, comments from the Committee to the staff. Otherwise, can we ask somebody in the control room to turn on the bridge line, see if there's comments from the public?

MS. BANERJEE: I'll make sure.

CHAIRMAN CORRADINI: Okay.

MS. BANERJEE: There were three members on the line.

CHAIRMAN CORRADINI: Okay.

So if anybody is out there --

Okay. Do we have members of the public that are out there, that want to make comments? Anybody out there? Is anybody out on the bridge line? Can you please at least acknowledge you're there?

(No response.)

CHAIRMAN CORRADINI: I don't hear anybody. So last comments from the Committee to staff or STP?

(No response.)

CHAIRMAN CORRADINI: All right. So let me just review what I heard -- where did staff go? He's behind me, okay. STP has agreed that they're going to get us a few things, just to finish this off. We're not going to have a meeting about it, but we will get things distributed to us from Maitri.

The technical basis, not necessarily the exact document, but a summary of the document on a technical basis for the one cubic foot is the limit.

We're going to get a table from STP that not only has the inventory of the material that would be or the inventory, what is expected to be the material making it to the core on a conservative basis, fiber, sludge, paint, dirt, rust, etcetera, but also the type of material and if it's a surrogate what the surrogate is, and distributions of sizes as they know it today, and that's all essentially backed with the asterisk or the proviso that things are still evolving.

But that will be at least what they know to this point. We've also been pointed to Appendix 6C for the -- 6C Rev 6, excuse me, for the test protocol, a summary of the test protocol, and also the high pressure core flooder and bypass assembly analysis, but those are summaries.

We've asked for the RAI or backup documents for both of those, and we'll get those so that the Committee has all that information, if we choose to go forward with a letter in the November time frame. Have I missed anything?

MR. HEAD: Mr. Chairman, we were also going to consider going back and looking at the bypass counts --

CHAIRMAN CORRADINI: Correct. I meant that, is that we were told that there's a summary in

Appendix 6C Rev 6 for both. But beyond --

MR. HEAD: Based on the nature of the questions today, I'm thinking you're probably not going to be reconciled to what you've seen.

CHAIRMAN CORRADINI: We always want more.

MEMBER STETKAR: I think that's a fair characterization.

CHAIRMAN CORRADINI: That's a fair characterization. So to the extent that you can provide it, we'd appreciate it.

MR. HEAD: Okay.

MS. BANERJEE: I understand this is something that staff had during their audit?

MR. HEAD: Yes, these have been looked at in audits.

MS. BANERJEE: There was a calculation base -

MR. HEAD: In terms of providing you some understanding.

CHAIRMAN CORRADINI: Okay. That's fine. Anything else from the Committee?

(No response.)

CHAIRMAN CORRADINI: Okay. In terms of future attractions, Mr. Chairman of the afternoon meeting, when are we supposed to be back here?

MEMBER STETKAR: One o'clock.

CHAIRMAN CORRADINI: And the subject is?

MEMBER STETKAR: The subject is land contamination, economic consequences, whatever you want to characterize that.

(Simultaneous speaking.)

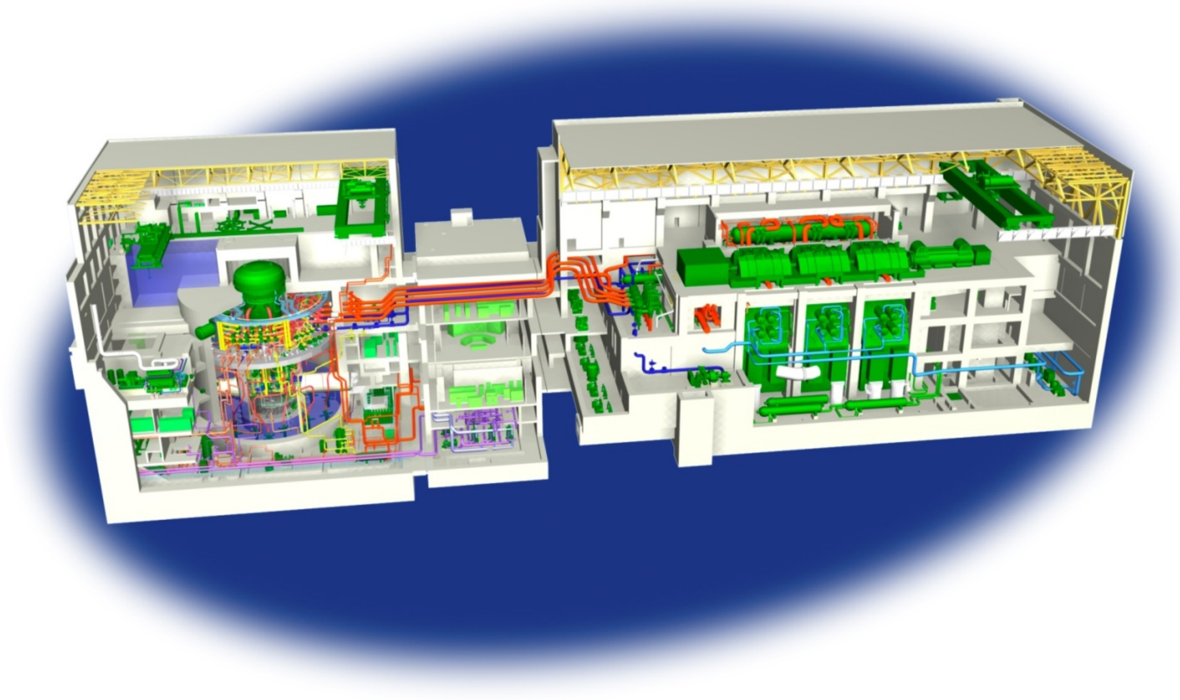
CHAIRMAN CORRADINI: A pretty boring topic, but we'll be back. With that, we'll adjourn for lunch.

(Whereupon, the above-entitled matter went off the record at 12:14 p.m.)

Nuclear Innovation North America LLC

South Texas Project Units 3&4 Presentation to ACRS Subcommittee

Long Term Cooling Follow-up



Attendees

Scott Head	NINA Manager, STP 3&4
Bill Mookhoek	NINA Licensing Supervisor, STP 3&4
James Tomkins	NINA Licensing, STP 3&4
Milton Rejcek	NINA Engineering, STP 3&4
Kenji Arai	Senior Fellow, Toshiba
Caroline Schlaseman	MPR/TANE
Martin Van Haltern	Westinghouse
Tim Andreychek	Westinghouse

Agenda

- Introduction
- Long term cooling overview
- Summary of key points from previous meetings
- Follow-up item # 80
- Summary

Introduction

- May 8, 2008 Staff Requirements Memorandum asked ACRS to advise Commission on adequacy of design-basis long term cooling approach for each reactor type
- Main focus was ability of safety systems to provide adequate core cooling for extended periods of time when the ECCS recirculation mode is activated during a design basis accident

LTC Overview

- Robust Long Term Cooling (LTC)
  - Numerous ECCS water sources to keep core cooled
    - Peak clad temperature during design basis LOCA is about half of the limit
  - Ultimate Heat Sink (UHS) has adequate water to provide cooling for 30 days without make-up
- Potential Challenges to Long Term Cooling are addressed
  - Strainers meet NPSH guidance
    - Strainers sized based on very conservative debris loading
    - AC Independent Water Addition system can provide core cooling water without using strainers (as a backup)
  - Containment integrity is maintained
  - Due to design features ECCS gas accumulation not an issue
  - Downstream fuel effects will be tested 18 months prior to operation
    - Long Term Cooling (LTC) met even with fuel assembly inlet blocked

LTC Overview - Conservatisms in Downstream Fuel Test

- Primary challenge to long term cooling is debris passing through the ECCS suction strainers and causing downstream effects on the fuel
- Design features that help ensure downstream fuel effects are mitigated:
  - Diverse water injection capability
    - HPCF from above core
    - ACIWA
  - State-of-the-art suction strainers
  - No fiber, calcium silicate, or aluminum in primary containment
  - Minimal zinc in primary containment (only in qualified coatings)
  - Design fuel assembly bypass flow
- Programmatic controls over containment and suppression pool cleanliness ensure latent debris amounts are low

LTC Overview - Conservatisms in Downstream Fuel Test

- There are a number of conservatisms in the downstream fuel test:
  - Debris Assumptions
  - Analysis for Acceptance Criteria
  - Test Performance

LTC Overview - Conservatism in Debris Assumptions

- Chemical amounts assume:
  - No solubility of zinc or aluminum corrosion products in the approximately one million gallon suppression pool
  - All chemical products form gelatinous precipitates
- No credit for settling of debris in locations where it will not impact the strainers or fuel, such as lower drywell, bottom of suppression pool, and lower plenum
- Latent fiber is all assumed to be 100 % fiber fines, with 100 % passing through the strainers
  - Since fibrous materials are prohibited, actual latent fiber in the plant is assumed to be rags and rope left in the upper drywell, which are not likely to pass through the strainer openings

LTC Overview - Conservatisms in Analysis for Acceptance Criteria

- Decay heat held constant at value at 5 minutes after shutdown
- Debris predicted to take more than 2 hours to all reach the strainer the first time, at which point decay heat would be 40% of the value at 5 minutes
  - Chemical precipitates such as zinc oxide are predicted to take about 15 days to reach the values used in the test
- Factor of 4 margin in acceptance criteria (factor of 2 in flow)
- Void Fraction of 0.95 at hot assembly exit (flow rate is greater than twice boil-off rate)
- No HPCF or fuel assembly design bypass flow is credited
  - Each by itself sufficient to provide adequate cooling

LTC Overview - Conservatisms in Test Performance

- Debris added in a manner that:
  - Minimizes clumping
  - Maximizes establishment of a fiber bed
  - Provides for the formation of a thin-bed

LTC Overview - Conservatisms in Downstream Fuel Test

- The collective conservatisms in the downstream fuel test translate to roughly a factor of 8 in flow margin
  - Analysis based on 5 min decay heat (~ twice the decay heat at the expected debris deposition time)
  - Analysis acceptance criteria (0.95 Void Fraction) requires twice the boil-off flow rate
  - Conservatism in acceptance criteria results in twice the required flow

ACRS Meetings on Long Term Cooling/ECCS Suction Strainers

- June 24, 2010
- March 8, 2011
- June 21, 2011
- October 4, 2011

6/24/2010 Meeting – Chapter 6

- Presented departure to upgrade suction strainers
- Discussed strainer design
- Presented strainer sizing analysis
- Introduced post-COL downstream fuel test

3/8/2011 Meeting

- Clarified the downstream test would use 1 ft^3 fiber and that chemical precipitates would be included in the test as well
- Provided comprehensive presentation on STP

  3 & 4 long term cooling
  - ECCS and UHS more than adequate to provide cooling for 30 days
  - Potential challenges to LTC addressed
- Detailed discussion on the downstream fuel test

3/8/2011 Meeting *(continued)*

- Presented "defense-in-depth" analyses showing that high pressure core flooder flow from above the core <u>and</u> fuel assembly bypass flow <u>each by itself</u> can provide adequate cooling for the core in the event the inlet to the hot assembly were to plug completely
- These bounding analyses provide additional assurance that LTC will not be compromised by downstream effects

6/21/2011 and 10/4/2011 Meetings

- Addressed follow-up items
- Table on next page shows summary of follow-up items

STP 3&4 LTC ACRS Follow-up Items		Meeting Date			
No.	Description	6/24/10	3/8/11	6/21/11	10/4/11
46	Boron concentration in sodium pentaborate tank	O	C		
47	a) Detailed briefing on downstream test b) Basis for only 10% of fiber passing through strainer	O	C		
49	Briefing on vacuum breaker protection	O	C		
50	Provide Toshiba technical reports used to size strainers	O	C		
72	Hydrodynamic loads on strainers		O	C	
73	Does analysis for Japanese plants bound thin bed effects		O	C	
74	Use of Nukon as a fiber surrogate		O	C	
75	Use of AlOOH as a chemical surrogate		O	C	
76	Zinc injection		O	C	
77	Justify partial length test		O	C	
78	Justify unheated test		O	C	
79	Justify use of NRC protocol for debris addition		O	C	
80	Pressure Drop vs. flow exponent of 2.0		O		
81	Address multiple tests		O	C	
82	Justify shorter loop transit time		O	C	
83	Inlet flow distribution assumption		O	C	
84	Parametric study of results vs. assembly inlet K-factor		O	C	
98	Modeling of perforated strainer screen			O	C
99	Zinc oxide concentration			O	C

O = Follow-up Item Opened C = Follow-up Item Closed

Summary of Actions from ACRS Meetings

- As a result of ACRS feedback:
  - Include 100% of 1 ft^3 fiber in downstream fuel test
  - Include chemical debris in downstream testing
  - Perform multiple downstream tests to account for inherent randomness of debris blockage behavior
  - Review industry experience with downstream tests for lessons learned prior to performing test

Remaining Follow-up Item

- Follow-up Item # 80

"Provide the basis for test acceptance criteria utilizing square relationship, vs. use of some other exponent such as 1.2 for debris bed."

Follow-up Item # 80 – Pressure Drop vs. Flow Exponent *(continued)*

- The conservative test acceptance criteria is:

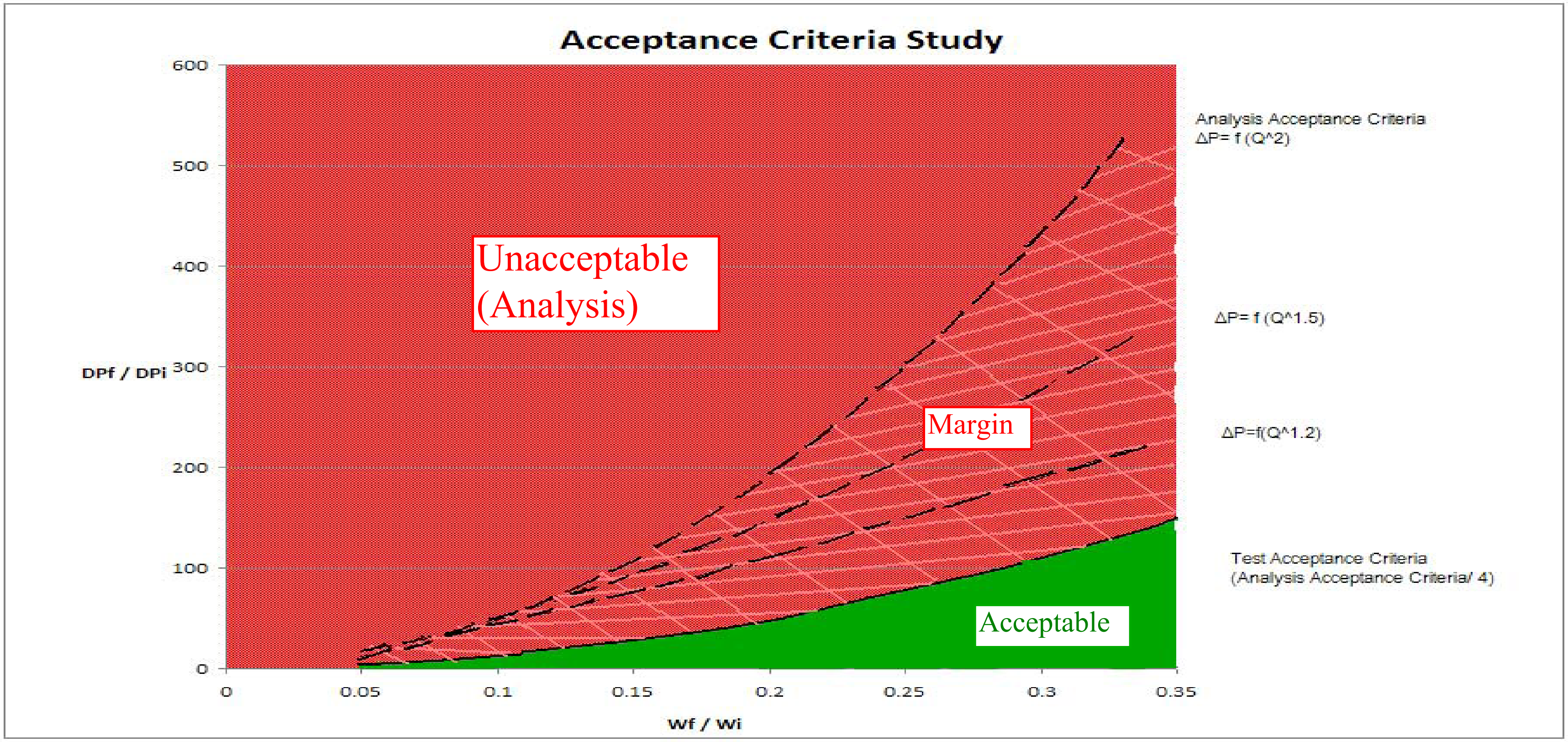
$$\left[\frac{\Delta P_f}{\Delta P_i}\right]_{(Test-Measured)} \leq 1200 * \left(\frac{W_f}{W_i}\right)^2_{(Test-Measured)}$$

- The criteria limits the increase in pressure drop due to the debris and is based upon an exponent of 2 in the Darcy equation
  - The allowed increase in pressure drop is determined from the GOBLIN analysis that ensures the core is covered by the 2-phase level.
- Exponent of 2 is reasonable value for higher debris loadings

Sensitivity Study for Debris Modeling

- The following overhead provides example calculations of the analysis acceptance criteria using different debris pressure drop vs. flow rate (Q) relationships
  - $\Delta P = f\ (Q^{1.5})$
  - $\Delta P = f\ (Q^{1.2})$
- These are compared with the analysis acceptance criteria (using $\Delta P = f\ (Q^2)$ and the conservative test acceptance criteria (based upon $\Delta P = (1/4)\ f\ (Q^2)$)

Study for Debris Modeling



Follow-up Item # 80 - Conclusion

- The conservative test acceptance criteria bounds the debris pressure drop vs. flow dependency variations.
- As discussed previously we believe the test acceptance criteria is appropriate and conservative

$$\left[\frac{\Delta P_f}{\Delta P_i}\right]_{(Test-Measured)} \leq 1200 * \left(\frac{W_f}{W_i}\right)^2_{(Test-Measured)}$$

Summary

- We believe we have addressed all the ACRS follow-up items
- There is adequate core cooling to meet LTC
  - ECCS and UHS are more than adequate to provide 30 days of cooling
  - Design basis LOCA peak clad temperature about half the limit
- Challenges to LTC (containment integrity, ECCS gas accumulation, and strainer NPSH) were satisfactorily addressed
- Primary challenge to LTC is debris passing through the ECCS suction strainers and causing downstream effects on the fuel
  - Conservative downstream test will confirm the design is not vulnerable to this challenge
  - Furthermore, defense-in-depth calculations show that there are two separate means of cooling a fully blocked assembly
- STP 3 & 4 meets regulatory requirements for long term cooling

Long-Term Cooling for ABWR STP Units 3 and 4 October 2, 2012

Jim Gilmer: Downstream Effects (Reactor Systems Branch)
Greg Makar: Chemical Effects (Component Integrity Branch)
Hanry Wagage: Containment (Containment and Ventilation Branch)
Tuan Le: Component Integrity (Engineering Mechanics Branch)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

ABWR Long-Term Cooling

- Long-term core cooling is provided by RHR and HPCF pumps
- Long-term suppression pool temperature is maintained by operating RHR in suppression pool cooling mode
- Analysis showed that containment pressure can be maintained below its design value
- Analysis showed that adequate core cooling can be maintained by keeping the RPV level above the top of active fuel

ABWR Long-Term Cooling (continued)

- The staff review approach for STP Units 3 and 4 is consistent with previous LTC reviews, and ensures that the requirements of 10 CFR 50.46(b)(5) are satisfied. The assessment includes:
  - ECCS strainer performance
  - Downstream effects
  - Chemical effects

Strainer Performance

- STP 3 and 4 ECCS suction strainers designed in accordance with RG 1.82 Rev. 3
  - Bounded by Reference Japanese ABWR strainer analysis and testing
- Primary containment - 100% Reflective Metallic Insulation
- Suppression pool
  - Stainless steel liner
  - Suppression pool cleanup system
- FSAR describes the Foreign Material Exclusion and cleanliness programs
- Restricted from containment by administrative procedures: fiber, CalSil, Al, and TSP

In-Vessel Effects

- STP demonstrated through analysis that 0.95 void fraction is maintained
- STP calculated peak cladding temperature is well within criteria specified in 10 CFR 50.46
- There are diverse ECCS injection sources and injection paths to core
- Fuel tests must demonstrate low impact on core flow due to debris blockage

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Conservatisms in STP Design/Analyses

- The relative reduced likelihood of latent debris generation compared to operating BWRs and PWRs (restricted access to the containment, the suppression pool cleanup system, the operational program for suppression pool cleanup)
- Minimal LOCA-generated debris (elimination of recirculation piping, no fibrous insulation)
- All breaks above top of active fuel
- All corroded aluminum and zinc assumed to precipitate in gelatinous form
- ABWR design features that minimize the transport of accident-generated debris
- Diversity of ECCS delivery locations, systems, and water sources
- The analyses include a factor of four conservatism

License Condition 06.02-1

- STP incorporates by reference the certified ABWR design
- The License Condition ensures that the fuel to be loaded will perform satisfactorily with debris blockage
- The proposed license condition includes test acceptance criteria that must be met for any type of fuel before it can be loaded
- FSAR COM 6C-1 commits to submission of the test results and analyses at least 18 months prior to scheduled fuel load
- FSAR COM 6C-2 commits to provide the complete, detailed test plan (which will reflect Industry experience in performing such tests) six months prior to the tests

License Condition 06.02-1 (continued)

- Acceptance criterion provides conservative measure of long-term fuel performance over the expected operating range

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Long-Term Cooling: Conclusion

- Adequate core cooling is maintained
- Containment pressure and temperature are maintained below containment design values
- STP meets 10 CFR 50.46(b)(5)