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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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JOINT MEETING OF THE THERMAL HYDRAULIC PHENOMENA AND RELIABILITY AND PROBABILISTIC RISK ASSESSMENT SUBCOMMITTEES

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WEDNESDAY

MARCH 18, 2015

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ROCKVILLE, MARYLAND

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The Subcommittees met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Sanjoy Banerjee and John Stetkar, Chairmen, presiding.

COMMITTEE MEMBERS:

SANJOY BANERJEE, Chairman

JOHN W. STETKAR, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

MICHAEL CORRADINI, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

GORDON R. SKILLMAN, Member

ACRS CONSULTANT:

WILLIAM SHACK

DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

ALSO PRESENT:

VIC CUSUMANO, NRC

DAVID JOHNSON, STP

PAUL KLEIN, NRC

BRUCE LETELIER, Alden

MIKE MURRAY, STP

WES SCHULZ, STP

STEPHEN SMITH, NRC

LISA REGNER, NRC

GEORGE WILSON, NRC

*Present via telephone

T-A-B-L-E O-F C-O-N-T-E-N-T-S

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

(8:31 a.m.)

CHAIRMAN BANERJEE: Good morning. The meeting will now come to order. This is a Joint Subcommittee meeting of the Advisory Committee on Reactor Safeguards' Subcommittees on Thermal Hydraulic Phenomena and Reliability and PRA. I'm Sanjoy Banerjee, Chairman of the Thermal Hydraulics Phenomena Subcommittee.

ACRS members in attendance are Dr. Schultz, Dr. Bley, Mr. Stetkar and Dr. Ballinger. Our ACRS consultant, former ACRS chairman Dr. Shack is also present. Mike Corradini will be on and off by phone during the morning and the afternoon. He has to actually be at the University of Wisconsin today. Derek Widmayer of the ACRS staff is the designated federal official for this meeting.

The purpose of today's meeting is for the NRC staff and representatives from the South Texas Project Electricity Generating Station to discuss the revised South Texas Project risk-informed approach to resolving Generic Safety Issue 191. Generic Safety Issue 191 is titled, "Assessment of Debris Accumulation on PWR Sump Performance."

The Joint Subcommittee will gather

information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for consideration for a future Joint Subcommittee meeting, which is currently scheduled for August of this year.

The rules for participation in today's meetings were announced as part of the notice of this meeting previously published in the *Federal Register* on August 19, 2014. The meeting will be open to public attendance. We have received no written comments or requests for time to make oral statements.

A transcript of today's meeting is being kept and will be made available as stated in the *Federal Register* notice, therefore we request that meeting participants use the microphones located throughout the meeting room when addressing the Subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume so they can be readily heard.

A telephone bridge line has been established for this meeting. To preclude interruption of this meeting, please mute your individual telephones and lines during presentation and Subcommittee discussion.

I ask that you please silence all cell

phones.

We will now proceed with the meeting. I call on George Wilson, Deputy Director of NRR's Division of Operating Reactor Licensing to make introductory remarks.

MR. WILSON: Good morning. As stated, I'm George Wilson, Deputy Director of Division of Operating Reactor License. I want to thank you for this opportunity and time to brief you on South Texas Project's risk-informed resolution to GSI-191, which is the assessment of debris accumulation in PWR sump performance and associated Generic Letter 2004-02, which began in 2011. STP is the pilot plant for the risk-informed process. This is an extremely complex review involving 13 technical branches and there has been three course corrections over the four-year effort.

We last met with the ACRS Subcommittee in October 2014 on this amendment. Since then STP has shifted its approach and proposed a new methodology that blends both risk-informed and deterministic methodology with two public meetings being held to discuss this new methodology.

NRC staff has held preliminary discussions on this, but has not yet received this information on the docket from South Texas Project. Right now the proposed is that we will receive this information in June 2015. And after the staff has a chance to look at that, we'll be able to come back and talk to the ACRS on our viewpoints on that.

At this point I would like to turn the meeting over to Lisa Regner, the project manager for South Texas Project, who will provide the path forward moving on with GSI-191 license amendment applications for South Texas Project. Lisa?

MS. REGNER: Thanks, George. I am the fairly new project manager for South Texas Project and I may be the primary presenter to you for the staff today, however, this is a team effort, as all NRC projects are, and I do want to recognize that I've been privileged to work with an exceptional group of professionals on the NRC staff. And I want to thank them for their patience with me and their support as we work through this GSI, or Generic Safety Issue 191, the assessment of debris accumulation on pressurized water reactor sump performance.

I've had the opportunity to present to you several times in the past, and I do appreciate the opportunity to present again today. This is a bit more unique than in the past, as George alluded to, not just because this is a first of a kind license application, but also because of these shifts that have taken place, which is completed expected during a pilot project as we're working through this extremely and unique pilot project.

Most recently in December the South Texas Project staff proposed to change their methodology in part to support the staff's requests to remove untested correlations, correct errors and to simplify the methodology. STP now proposes to use both deterministic and risk-based methods, as George said, and they've termed that risk over deterministic or RoverD, which they will explain in much more detail for you today. Again, the staff does not have a formal docketed submittal from the licensee, and because of this the staff is somewhat limited in its ability to provide details on this new methodology.

With this in mind, I'd like to provide you a very, very efficient look back and look forward on this pilot project and then get out of the way and let STP give you the details, which I'm sure you want. We will be able to give more feedback and answer questions further on this project once we're able to review in more detail, and we'll look forward to the August presentation where we can give you more feedback.

The first part of the presentation is the deterministic. We do have a lot of details. And Mr. Steven Smith, reactor systems engineer in the Safety Issues Resolution Branch, will be providing a detailed look at his observations since he did observe that testing. So in addition to STP's detailed look, the staff will give you details and will be able to answer questions on that aspect.

But in terms of the RoverD, the staff does have few details and they're based on one public meeting. But again, I do want to speak for the entire team in saying that we do appreciate the opportunity to be here and we welcome any feedback, insights and perspectives that you're willing to share with us today.

So in terms of the background, this is a pilot project. It's a first of a kind. And though this slide does show some of the challenges and course corrections that have taken place over the past four years, as George said, it is unique and complex. I have only been here for about eight weeks, but there are many that have been on this project for four years, and they've been jogging. If you'll indulge in this analogy, they've been climbing a rocky hill, both sides have, but based on what we have seen of RoverD we are hopeful that we're either close to cresting the hill or we already have. We do see merit in this new methodology and we do look forward to receiving more details, as you do, from STP. I do want to thank both sides for their patience as we work through this pilot program.

We did have 18 pre-submittal meetings in 2011-2012 in anticipation of the January 2013 pilot submittal. Unfortunately the submittal did not include an amendment, and there were a few other insufficiencies noted by the staff. Therefore, STP revised the submittal again in June 2013 and due to some self-identified issues they then again supplemented in June 2013. We do expect another supplement -- I'm sorry. They supplemented again in November 2013. And then we expect the RoverD submitted in June of 2015.

Requests for additional information that have been issued. In April 2014 the staff issued round 1, and a couple of those technical issues, which I believe you have discussed previously, were the use of correlations, the treatment of chemical effects on coating, debris generation and transport, the verification of the containment accident sequence, stochastic analysis or CASA Grande. This is actually the probabilistic risk assessment platform that they use for the PRA and the treatment. And it also includes uncertainties and sensitivities, in-vessel effects and loss of coolant accident size and frequency. And there were several responses that this slide doesn't show. There were three STP responses in the summers of 2014 and 2014.

We also issued round 2 RAIs which included many of the same issues in March 2015. Those responses are due at the end of this month.

Recent public meetings we have had. I do want to say that we've had almost 30 public meetings over this four-year period. The most recent were in December, February and March, which February 4th was the most significant one where we covered the new RoverD project where -- I'm sorry, STP provided us a presentation on the RoverD process. And that was well received by the staff.

We've had regulatory audits. We do have several upcoming audits associated with GSI-191. The most recent one is actually tomorrow at Westinghouse. We'll be looking at in-vessel effects during design basis accidents specific to boron precipitation calculations. At the end of this month the staff will be going to STP and actually will enter containment during their outage to look at some of these affected areas, areas affected by GSI-191. And we think that will provide a good look, a good perspective of a real-life look at what we're all dealing with on paper here at headquarters. We also expect a spring audit associated with the RAI responses, and there are two more possible over the summer following the RoverD submittal.

The environmental assessment has been completed. We still have to do an evaluation to see if that will be affected by the change in methodology, but we will issue that in draft for public comment and then issue the final when and if the staff approves the GSI-191 resolution.

Upcoming submittals, as I mentioned, are both March, the round 2 RAI response, and June for RoverD.

We also have more ACRS meetings coming up. The third Subcommittee this summer and then a full Subcommittee meeting is proposed this fall. So we'll have two more opportunities to provide you with our perspectives.

Outstanding technical issues. Many of those I've mentioned before. They are captured in the RAIs that are currently on the docket.

Application completeness and consistency, variability of the submittal. We're hoping to get a fixed and complete submittal for review very soon, and hopefully that will be with the June submittal.

Un-analyzed accidents scenarios. That has to do with situations or sequences that weren't modeled by CASA Grande, but that the licensee was not assuming a conservative outcome. And the staff stressed that that would be important for those un-analyzed accident scenarios to go to failure.

Use of correlations. That's been discussed quite a bit.

Debris generation and transport largely associated with coatings.

And again, validation of the model, CASA Grande model. We've had difficulty performing an independent assessment of CASA Grande results that were in the ballpark. We do believe we've worked through most of those issues but still have some work to do there.

And I do want to say --

MEMBER BLEY: And can you send --

MS. REGNER: Sure.

MEMBER BLEY: -- in more about that?

MS. REGNER: About the validation with models?

MEMBER BLEY: Yes, what problems you were having and are you really close to resolution?

MS. REGNER: We're getting close. For a while we were quite a bit off. And in terms of --

MEMBER BLEY: That's using their code?

MS. REGNER: Correct. Getting the results from their code and using our independent assessment to determine --

MEMBER BLEY: Okay.

MS. REGNER: -- debris transport. We weren't real close. Okay? Now more recently we've discovered some issues with the use of the most current modeling and the most current input data values.

MEMBER BLEY: This is NRC's model?

MS. REGNER: Correct.

MEMBER BLEY: Okay.

MS. REGNER: Correct. The input data for those models. But for example, another issue is this idea of the moving target, the consistency. In our last public meeting on March 11th, when we felt like we were starting to converge and get closer in the ballpark, STP had noted that they had used -- for insulation loading they had used their new CAD model instead of a much more broad -- I want to say there was a larger estimate previously that we had been given, but they had then used a more accurate insulation loading.

MEMBER BLEY: Which isn't what you were using?

MS. REGNER: Which isn't what we were using.

MEMBER BLEY: Okay.

MS. REGNER: And so, and we didn't know about that. So those kinds of issues are what we need to figure out. What are they actually using that we don't know about, those --

(Simultaneous speaking)

CHAIRMAN BANERJEE: What about the ZOI? Was it 7 or 17? I mean, that's the first order of problem, right?

MR. SMITH: This is Steve Smith. The ZOI they're using is 17D for the fibrous insulation, low-density fiberglass.

CHAIRMAN BANERJEE: Okay.

MS. REGNER: Thanks, Steve.

CHAIRMAN BANERJEE: And there's no settling of the fine and fiber, or are they taking account of that?

MR. SMITH: They're probably going to get into that later, but the transport evaluation assumes very little holdup of any fine, either particulate or fibrous debris.

CHAIRMAN BANERJEE: Okay. So it's more or less consistent, right? It's just what's within that 17?

MR. SMITH: Yes.

MS. REGNER: Okay. Any other questions?

MEMBER SCHULTZ: One, Lisa.

MS. REGNER: Yes?

MEMBER SCHULTZ: You mentioned the audit that's going to be performed to examine the containment during the outage.

MS. REGNER: yes.

MEMBER SCHULTZ: It sounds like a very important opportunity to capture whatever might be important to the overall evaluation of not only the analysis, but also the application.

MS. REGNER: Absolutely.

MEMBER SCHULTZ: Is the audit plan prepared? Have you been --

MS. REGNER: It is in draft.

MEMBER SCHULTZ: -- working through what you're going to see and what you need to see?

MS. REGNER: It is in draft. It was given to the licensee last Friday, yes. I can get you a copy of that, get you the final. It should be finished this week or early next week. But, yes, we do have --

MEMBER SCHULTZ: At the final time I'd like to have an opportunity to see that.

MS. REGNER: Absolutely.

MEMBER SCHULTZ: Just in making sure that's optimized. I'm presuming licensee is making sure that's --

(Simultaneous speaking)

MS. REGNER: They invited us.

MEMBER SCHULTZ: Of course.

MS. REGNER: So we do thank the licensee for that invitation, yes.

MEMBER SCHULTZ: Good. Thank you.

MR. CUSUMANO: Yes, excuse me. This is Vic Cusumano. The audit plan isn't going to be tremendously detailed. We are intentionally leaving it a little bit open-ended. We want to look at systems and structures and components that they're referencing in their submittal to us and --

MEMBER SCHULTZ: I'm probably more interested in the audit report.

MR. CUSUMANO: That's kind of what I figured.

MEMBER SCHULTZ: But, yes. So some combination thereof would be useful for us.

MR. CUSUMANO: More of interest would

probably be the audits that we do later of the actual inputs, to validate the inputs to CASA Grande.

MEMBER SCHULTZ: Thank you.

MR. WIDMAYER: Lisa, as usual, you can just work through me.

MS. REGNER: Will do. Very good. Understand. I will get you audit plan and audit summary for the audit at the end of this month, March 31st.

MEMBER SCHULTZ: Thank you.

MS. REGNER: We do expect that many if not all of these outstanding technical issues will be resolved or largely resolved if the RoverD methodology is in fact what we think it is.

Debris generation and transport, obviously those issues will still need to be worked through.

That basically concludes my presentation.

MEMBER BLEY: Just two quick questions: When are you expecting their submittal? And given it comes when you expect it, when do you expect to have your review complete?

MS. REGNER: When does the staff expect to complete its review?

MEMBER BLEY: Yes.

MS. REGNER: If all goes well, I would say probably the first calendar quarter of 2016.

MEMBER BLEY: Okay.

MS. REGNER: Okay. And that's assuming no RAIs, assuming we get exactly what we need. That's best case scenario.

MEMBER BLEY: Fair enough. Okay.

MS. REGNER: Any other questions?

(No response)

MS. REGNER: Okay. With that, I will turn it over to South Texas Project. Thank you so much.

CHAIRMAN BANERJEE: So, welcome. Mike, you are going to lead?

MR. MURRAY: Yes, I will. Well, let me go ahead and start. Let's do our introductions from those who are here to support South Texas Project, and then we'll get into the slide show.

Mike Murray. I'm the reg affairs manager at South Texas Project. And to my left is Wayne Harrison, our licensing representative. Ernie, would you start?

MR. KEE: Ernie Kee, South Texas Project.

MR. SCHULZ: Wes Schulz of South Texas.

MR. HARRISON: I'm Wayne Harrison, South Texas.

RICHARDS: Drew Richards, South Texas Project, Licensing.

MR. RENCURREL: David Rencurrel.

CHAIRMAN STETKAR: Come up to the microphones.

MR. RENCURREL: David Rencurrel. I'm Senior Vice President of Operations, South Texas.

MR. ENGEN: Rob Engen, Engineering Projects, South Texas Project.

MR. DUNN: Roland Dunn, South Texas Project. I'm Nuclear Fuel and Analysis Manager.

MR. JOHNSON: David Johnson, ABS Group supporting South Texas.

MR. LETELIER: Bruce Letelier, Alion Science supporting South Texas.

MS. LEAVITT: Janet Leavitt, Alion Science supporting South Texas.

MR. HASANBEIN: I am John Hasanbein from the University of Texas at Austin supporting South Texas.

MS. MOHAGHIGH: I am Zahra Mohaghigh from the University of Illinois supporting South Texas.

MR. VAGHETTO: Rodolfo Vaghetto, Texas A&M University supporting STP.

MR. MURRAY: So with that, we'll get into our slide show. Again this is Mike Murray from South Texas Project. And I'm going to practice with our scroll to make sure it works here. Yes, it's working.

So what we would like to do today is go through the introduction of the risk over deterministic. And as you can see, -- as in nuclear power, we always have to make an acronym for it. So we call it RoverD. So that's the term you'll often hear as we're going through our presentation.

And how we'll go through it is we'll explain -- and in an early slide I'll kind of show a flow diagram. We'll talk more about that slide later in the presentation, so we won't need to spend a lot of time on it. It just gives you a concept of it. We're going to go through and deterministic element of it. And what we'll do is we'll go through test results that are the basis for our deterministic screening process within it. And then we'll get into how that applies and into the risk element. And then Wayne will carry us through the regulatory basis, and then we'll go through conclusions.

Now there was one thing that we'll talk about. Steve, when did you want to interject your thoughts, because Lisa indicate you would. So I'd like to work that in.

MR. SMITH: Okay. I guess it's on the schedule. But any time after you finish talking about the testing.

MR. MURRAY: Okay. So that will be a good opportunity.

MR. SMITH: The 2008 testing.

MR. MURRAY: So we'll work through that as we get to that point, and that will probably be around the first break, or maybe right shortly after it there.

CHAIRMAN BANERJEE: Well, Steve is currently scheduled to talk after lunch.

MR. MURRAY: Okay.

CHAIRMAN BANERJEE: So we'll finish the deterministic.

MR. MURRAY: Right. We'll see how it works and see where it fits well. And I'll pay attention to that as we go through it.

So I am now on slide 3. Some discussion about it is we have revised this methodology. One point I want to make as we've gone through it is that in each opportunity we've had the risk continues to be very low as in the results of every methodology that was approached as we've gone through the phases. The risk of the final still continues to be very low. So I just wanted to make that point going in.

And also I wanted to update one thing. So we're currently in a process of requests for additional information and included in our March will be the RoverD technical information for the staff to look at. So we'll have that in our March submittal of requests for additional information. So that will help the staff in preparation for when we see it in the June, when we bring all of the submittal together.

CHAIRMAN STETKAR: So, Mike, what you're saying is as part of -- I looked through the RAIs -- as part of responses to those RAIs you're basically going to append the whole new methodology?

MR. MURRAY: We're going to include the new methodology that we'll discuss today in that RAI response so the staff will be able to start their review on it --

CHAIRMAN STETKAR: Okay.

MR. MURRAY: -- as we're working on bringing up, as Lisa said, in June all the pieces of the submittal and updating it to RAI responses and preparing it for the final reviews.

MEMBER SCHULTZ: So you'll have a full integrated package that you'll be presenting in June?

MR. MURRAY: That is correct. That is currently our schedule and target.

So go ahead, Wayne, did you want to add?

MR. HARRISON: No, I was nodding in

agreement.

MR. MURRAY: All right. So where we are is we've -- again we're moving into with a deterministic baseline. And then when we screen through that process, you'll see what remains. And we'll apply a probabilistic or risk-informed approach to it. So the RoverD is less complex. Again, that was the purpose of this change was to get some of the complexity out to clarify the path as we go through it. And you'll see that as we go through it. And please ask questions as we go through it. Not so much of me. Lisa will be able to answer questions.

CHAIRMAN STETKAR: Mike, be careful with the papers.

MR. MURRAY: I understand.

CHAIRMAN STETKAR: That microphone is sensitive.

MR. MURRAY: Thank you for that reminder.

So moving to the next slide. So high level we assume that all breaks that can introduce more fine fibers than what we have in our test will lead to core damage and then we'll apply that into the probabilistic part of the process, the risk-informed portion.

We'll screen the spectrum of break scenarios at all weld locations, find a set of the smallest breaks that introduce the more fine fiber. We'll assume the larger breaks of the same location will exceed the fine-fiber limits. And then we'll add the cumulative frequencies of these events. And we'll get into that this afternoon.

So I wanted to first introduce this from a pictorial. So you can follow it as we go through it. This is how the rubber meets the road, if you could imagine, is we look at the deterministic test data. We examine the breaks. We look for the amount of fine debris out of each break and we base --

MEMBER SHACK: This afternoon are you going to discuss what fine debris is sufficient to characterize the complexity of the loading?

MR. MURRAY: We will make sure we do, yes, sir. I think we do.

And then we carry it into a decision tree, and it really comes down to a true faults almost. Is it less than or not? And if it is not less than, then you get into the -- you take the no line and then you apply the risk-informed utilizing the guidance in Reg Guide 1.174. If the amount of fines meets the yes line going through, then you just -- the scenario is deterministically screened.

CHAIRMAN BANERJEE: Is this a clean plant in terms of latent debris?

MR. MURRAY: So what's the term? Clean in --

(Simultaneous speaking)

MR. SCHULZ: We are a high-fiber plant, so our latent debris is a very small contributor to our total fiber fines.

CHAIRMAN BANERJEE: I'm just baselining in my head that even plants which are very clean have downstream effects which are in excess of the typical 15 grams per channel that you've allowed. So I'm just trying to baseline what the fines are like. Is it 200 pounds, the fiber? I mean, in total latent debris?

MR. SCHULZ: Latent debris? Yes, 200 pound latent debris. That's what we assumed.

CHAIRMAN BANERJEE: Is that what --

(Simultaneous speaking)

MR. SCHULZ: Which 15 percent is fiber. That was our assumption going in, yes. But that amount is small compared to the amount --

CHAIRMAN BANERJEE: What you will generate. Yes.

MR. SCHULZ: -- that is generated.

CHAIRMAN BANERJEE: So it will be interesting to see how you -- and are you trying to adhere to to this 15 grams per channel downstream, or is there something else?

MR. KEE: We do.

MR. MURRAY: So with that, I think our next slide -- I'll turn it over to Wes and Wes will take us through the test. Again, this is the test that we're using as our baseline for the window down below that says -- that I'm pointing to which is total fine less than tested. So that's where we're setting up that deterministic gate.

MR. SCHULZ: Hi, my name is Wes Schulz. You'll note that there are a couple ways to spell Schulz, but we pronounced it Schultz. That's how we do it.

(Laughter)

MR. SCHULZ: I'm a mechanical design engineer at South Texas Project. I've been there working on this for a long time.

Okay. I'm going to give you a little bit of STP background, just a quick description of our plant and what it's like. I'm going to talk about the role of flume testing, overview of our deterministic analysis that we did in '07 and '08 and then the testing that was done in '08, talk about the test itself and then how we're going to use this test going forward in our RoverD approach.

And, Steve, when I'm done talking, it would probably be good for you to jump in and talk about that, because I'll be talking about the D in the RoverD. And then when I'm done with testing you can jump in.

This is a way too busy figure here. This is an elevation view of the various complements, but the take-away here is I want to make the point that we have three independent trains at South Texas. Each train has its own sump, independent sump with strainers. There's a low-head safety injection pump, a high-head safety injection pump and a containment spray pump. During injection phase it takes suction off the refueling water storage tank. And then during the recirc phase it takes suction off the sump.

We have separate RHR, residual heat removal pumps, which is a separate system which we're not using in the recirculation mode. So that's the main thing about South Texas. So we have three separate trains each with its own pump. And the pumps are located below the sump level in the bottom of the containment and the pumps are located in another building, the fuel handling building, which is lower than the containment floor elevation there. So that's the take-away from that slide.

That's a picture of our old sump strainer.

It's about 4 foot high, 4 foot wide and 10 foot long. It's just a box with quarter-inch perf plate surrounded by grating. It's about 155 square feet.

This is picture a taken during an outage, so that's why there's a box of wipes there and some scaffold frame in front. They were working above the sump at that time.

We removed this back in '06-'07 and put in our new advanced design sump strainers. And these consist of about 20 modules per sump. And these modules here. And they connect to a collection box, a plenum box here. And underneath that is our sump pit.

CHAIRMAN BANERJEE: These are just disc strainers?

MR. SCHULZ: They're discs, yes.

CHAIRMAN BANERJEE: What are the hole sizes?

MR. SCHULZ: Point oh-nine-five inch.

CHAIRMAN BANERJEE: Point oh-nine inches? Is that sort of standard?

MR. SCHULZ: Those are standard. Florence Contracting, Incorporated made these strainers for us and several other folks in the industry. They're installed in several plants.

CHAIRMAN BANERJEE: And the spacing

between them is?

MR. SCHULZ: The spacing between discs is about an inch. You can sort of see it there.

And here, after the strainers were installed, a couple years later we installed this protective grating around it. That's just to protect them during outages so no one runs into them and to preclude damage to the strainers during a maintenance state.

Here's a picture of inside containment. I think that's me. That's my head that. You can tell by my green eyes.

(Laughter)

MR. SCHULZ: We're called a high fiber plant because we have NUKON insulation inside containment with all the lines. These are NUKON blankets here that has the fiberglass inside. All the lines are insulated inside containment with the NUKON.

There's the next slide here. This shows another picture here. More NUKON insulation. That here with a metal jacket on it, that's the reactor coolant line that. Underneath that metal jacket is just a NUKON blanket like we have here. When we do our debris generation, we don't take any credit for that jacket. So it doesn't matter whether it's jacketed or un-jacketed. It's still just the same assumption there.

MEMBER SHACK: Where is your Calsil type insulation used?

MR. SCHULZ: Calcium silicate was used inside here on the reactor vessel nozzles. It was there. In 2008 it was there. So during the test we used that in our strainer head loss testing, but subsequently we removed that insulation about two years after that. So we had no Marinite. Marinite's a trade name.

MEMBER SHACK: Yes. Right.

MR. SCHULZ: It's calcium silicate. We removed that so there's no calcium silicate insulation inside containment now. So our degree of insulation is the fiberglass insulation on the piping and then on the equipment. So the steam generators and the reactor coolant pumps also have this low-density fiberglass insulation.

CHAIRMAN BANERJEE: If I remember the original argument where all this started, was that you to remove this and replace the insulation would give a fairly radiation dose to the workers, right? That was that --

MR. SCHULZ: That was the rationale for --

CHAIRMAN BANERJEE: -- rationale for going to the Commission and trying to get them to do this, right?

MR. SCHULZ: Right. That is correct. I mean, you see here lots of lines all over the place. It would be a big dose impact to do that.

CHAIRMAN BANERJEE: I also remember they were deferring estimates or that at that time from different sources.

MR. MURRAY: I think it was 50 rem or greater per unit. It was --

MR. HARRISON: I was reviewing what we put in our application last night, and we had our estimating people actually look at that and they estimated somewhere between 156 -- realistic estimate they thought was about 156 to 170 rem. That's for both units, so it would be half of that for each unit.

CHAIRMAN BANERJEE: Yes, I seem to remember numbers of that order. Okay. Go ahead.

MR. SCHULZ: So that was the rationale for going forward with this approach, what we're doing here.

So that's the background. STP has three safety trains, a high-fiber plant, insulation fiber from pipe insulation and equipment insulation.

CHAIRMAN BANERJEE: Just a question for my own sort of clarification here. When that estimate was made, that was to remove all the high fiber regions, I mean, all the NUKON, or --

MR. SCHULZ: Yes.

CHAIRMAN BANERJEE: -- only the ones that were the most impacted by the breaks?

MR. SCHULZ: That was for all of the --

CHAIRMAN BANERJEE: So it wasn't sort of greater than what was the highest --

MR. SCHULZ: Once you started grading it, we concluded it that, oh, there's some more, there's some more, there's some more. So it was all --

CHAIRMAN BANERJEE: Are there regions where it can be removed relatively readily and impact things positively in terms of fiber generation without getting a huge dose?

MR. SCHULZ: Well, let me show the next slide. Thank you for that segue.

(Laughter)

MR. SCHULZ: Here is 17D ZOI. Seventeen D means the radius of that zone of influence is 17 times D. In this case it's a 31-inch double-end guillotine break at the steam generator nozzle here. So 31 inches, 22 feet times 17 is 34 -- maybe a 40-foot radius sphere. So all that in there would have to be replaced.

CHAIRMAN BANERJEE: But most -- not all, but most of the debris would be generated off the steam generator, right?

MR. SCHULZ: There's a lot --

CHAIRMAN BANERJEE: A lot of it?

MR. SCHULZ: -- of it in the steam generator, yes. And even that, that would be a big dose hit, too.

CHAIRMAN BANERJEE: That's the question I'm asking.

MR. SCHULZ: Yes.

CHAIRMAN BANERJEE: Is that going to be a very big dose?

MEMBER SHACK: Supposed you screen with your RoverD so you only removed the insulation that was affected by the things that didn't pass your deterministic screen.

MR. MURRAY: This question, I think when we -- and I'm not trying to put that question off, but I think as we go through it you'll start to see what the results would show us and what the results show us of what welds are left over that don't screen out. I think that -- let's revisit that question at the end. I think we'll have a better appreciation for it.

CHAIRMAN BANERJEE: Let's note that and

we'll take it up after.

MR. MURRAY: Yes, as we work through it I think you'll have a better appreciation for the answer having seen how we get to that answer.

MR. SCHULZ: So that gives a perspective of what a 17D ZOI looks like in containment. We have a four-loop plant, so we have four steam generators.

So that's a couple -- overview here. The role of flume testing. We wanted to look at our strainer performance. So the test shows that most of our failure concerns are resolved deterministically. In July 2008 we did these tests based on our response. We were responding to the generic letter. The fiber loading was based on two trains in operation. That was our design basis. Two trains operating out of three. So we split the debris among two safety trains going to two different sumps.

We used high fiber loading. We used particulate loading. And we used chemical loading, too. We used chemicals that were generated in accordance with the approved WCAP methodology for --

MEMBER SHACK: So your particulate loading would be very conservative now because you've gotten rid of the Calsil?

MR. SCHULZ: That's part of it, yes. But

we still have other coatings in there, too. We'll see that coming up, too, yes. But the Calsil was in there, yes. But that was -- we'll see --

(Simultaneous speaking)

MEMBER SHACK: Well, I guess that's chemicals, too, yes.

MR. SCHULZ: We had chemicals, too.

The test was successful. We met our objectives. The strainer performed adequately. It was acceptable. So the deterministic land, that was a successful test and we -- with that debris loading. And now we're going to use that debris loading as our screen for going forward in the RoverD approach, and which would eliminate the need for a head loss correlation. So we're not using a head loss correlation in our approach anymore.

The purpose of the test was to show again we had adequate strainer performance. We used the guidance of the NEI document to go through our methodology. And we'll discuss that in a little bit. Instead of test for success objective, now we look at a spectrum of LOCA events. That's with our RoverD we will look at breaks, different places, different size breaks rather than just one design basis break. And then we'll talk about our July test that we did.

We did calculations to address each element of the content guidance. The analysis was several -- the analysis was done back in the 2007-2008 time frame. We came up with acceptance criteria for the different strainer performance elements and we used a flume test of a full-scale module using representative STP debris. We'll talk about that in a little bit.

CHAIRMAN BANERJEE: So these flume tests had enough turbulence that you didn't get settling of fine debris?

MR. SCHULZ: We'll talk about that. Yes, we'll show you that, but yes.

CHAIRMAN BANERJEE: But yes or no? Did it allow or not?

MR. SCHULZ: It was mild, to be representative of our sump conditions. So we took the --

CHAIRMAN BANERJEE: What does that mean?

MR. SCHULZ: We took -- I'll show you. We did velocity profiles near the sump and we replicated that in our testing to show the velocity --

(Simultaneous speaking)

CHAIRMAN BANERJEE: But the sumps that you've got, how do you estimate the Reynolds numbers of the flows? It would be very high coming in, right?

That's one of the reasons why it's very difficult to do that, that we've always been skeptical about settling.

MR. SCHULZ: Well, we did CFD analysis to figure out what the velocity profile was adjacent to the sump and we -- I'll show that in a minute.

CHAIRMAN BANERJEE: Yes, you can show us that.

MR. SCHULZ: Yes.

CHAIRMAN BANERJEE: We'll see what the basis of settling is.

MR. SCHULZ: Yes, we'll talk about that. You've asked that twice already, so I know --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Is it important?

MR. SCHULZ: Settling, we want it to be representative in what we're doing.

CHAIRMAN BANERJEE: Okay.

CHAIRMAN STETKAR: Wes, could you back -- and I'll have to defer to the good Dr. Banerjee, but the loading in the test that you did in 2008 was based, you said, on the assumption that two trains --

MR. SCHULZ: Yes.

CHAIRMAN STETKAR: -- of equipment were running, which is your design basis?

MR. SCHULZ: Yes.

CHAIRMAN STETKAR: The risk assessment assumes that you can succeed with only one train running.

MR. SCHULZ: That is part of our risk assessment. Ernie will speak more to that point. It's just a single train operation.

CHAIRMAN STETKAR: My question is if you had only a single train running, how would have that flow distribution affected the fiber loading for that testing? Would you have had more loading on the strainer with only one train running?

MR. KEE: We assume that in our analysis. When we assume a single train, we assume that it loads with the same quantity as two trains running. We tested. So that means you can only tolerate half the amount. In truth it would be a lot lower. There would be a lot more settling.

CHAIRMAN STETKAR: Okay.

MR. KEE: So it's conservative in that regard. And on top of it we come through to recirculation with success, with a single train, but in truth it's a 60/40 split because that single train may be going out of break location. So actually we overestimate the success of that state in our analysis, because we assign all the frequency that we come through with that configuration to success.

CHAIRMAN STETKAR: Yes. Okay. I'll have to think about that. I just want to make sure that -- because we're now relying on those tests a lot. I understand the change in the -- the risk information is also changing in terms of what you're assuming, but I just want to make sure that I understand the direction we're going in.

MR. SCHULZ: Ernie, that's part of your presentation later on, right? Okay.

MR. KEE: I think you'll find that we've dealt with that, yes.

CHAIRMAN STETKAR: I'll wait. Thanks.

MR. SCHULZ: So all this work was going on in 2007-2008 and we did our submittal in December of 2008 using the content guide from the staff. And these are the sections in that content guide that the industry used. And I'll briefly talk about each of these things. These are all our deterministic analysis that we did in 2008. And I'll talk about what we did for that that we --

(Simultaneous speaking)

CHAIRMAN BANERJEE: So these tests were done where, in New Jersey or Pennsylvania?

MR. SCHULZ: In Massachusetts at Alden

Research Lab.

CHAIRMAN BANERJEE: Go ahead.

MR. SCHULZ: Okay. So I'll talk about each of these in our deterministic approach here that we've done. Break selection is the first one. For 2008 analysis we had to pick a break that would generate debris for our test. And so these are the criteria from the NEI guidance as to how you select breaks. And we came up with breaks. And actually we did our test. We used like a couple of different breaks to give us a bounding amount of debris in when we did our test.

This is the basis of the test, but going forward we'll use the actual amount. And we'll talk about that again. The actual amount that was used is our yardstick, is our ruler going forward for our screening.

And then debris generation. Most of the debris is from low-density fiberglass, which in 2008 we used 7D ZOI, and which resulted in 192 pounds of fine low-density fiberglass fibers. That's our metric. That's our screen. That was what was used in that test in July that had successful strainer performance. And that's the parameter we're going to us going forward in our --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Which is the parameter? The 192?

MR. SCHULZ: Hundred and ninety-two is our -- that's our bar. So if we're under the bar, we'd call that acceptable. If we're over the bar, then we'd go to the risk-informed approach.

CHAIRMAN BANERJEE: Above 192 pounds you found too high a head loss. Is that it?

MR. SCHULZ: We didn't test for that.

CHAIRMAN STETKAR: They're assuming.

CHAIRMAN BANERJEE: Okay.

MR. SCHULZ: We assume of -- it's in failure. Ernie will get into that, but, yes, we didn't test to see what the upper bound was. But that was successful strainer performance with that number there, which was --

CHAIRMAN BANERJEE: Did you also measure the pass-through the strainers?

MR. SCHULZ: Penetration? We did that in an earlier test, too.

CHAIRMAN BANERJEE: So you got how much fiber pass-through?

MR. SCHULZ: We'll talk about that later on.

MR. KEE: We'll show you --

MR. SCHULZ: And there's another aspect of our --

MR. KEE: -- the data that we collected for that test.

CHAIRMAN BANERJEE: Okay.

MR. SCHULZ: Yes, that will be Ernie's presentation.

CHAIRMAN STETKAR: Just to keep me oriented -- I try to look forward, and stop me if you're going to -- and I know you will. But you're basically heading in a direction where you're going to try to show that with now a 17D zone of influence, as long as you generate less than 192 pounds, you win, in simple terms. Is that right?

MR. MURRAY: That's it.

CHAIRMAN STETKAR: Okay.

MR. MURRAY: That's that box, that decision box.

CHAIRMAN STETKAR: Right.

MR. MURRAY: That's the number that's in the decision box.

CHAIRMAN STETKAR: Okay. Thanks.

MR. SCHULZ: And what I'm going through now is all those winning conditions and show you how we analyze it. And it generally was per the NEI methodology that this -- per what the staff has accepted. So that's what we're taking credit for here.

Debris characteristics. That was in our submittal. We talked about that per the NRC approved guidance.

Latent debris. This is what we talked about before. We did walkdowns to determine we had 165 pounds. Two hundred pounds we used in our test. When we approach 15 percent, 30 pounds was fiberglass fines, which ended up in our flume for debris loading.

Debris transport. Again we used the standard methodologies. We use a transport fraction of 95 percent of fines generated, got transported to the sump. And we also used one percent of large and small fiberglass pieces. One percent of that was considered as fines from erosion of those pieces that are in the flow stream. So that was the contribution to the 192 pounds we used.

Our strainer vendor did head loss and vortexing calcs. We don't have a vortexing issue with the PCI strainers. Air ingestion is our criteria. And void fraction was less than two percent. These are all the standard methodologies that we used for our submittal back then.

Net positive suction head. We did

calculations and PCI did calculations. We used max flow rates and standard assumptions to figure out our NPSH available excluding the strainer and debris and NPSH required for our three different pumps to determine clean strainer head loss. Our debris head loss is based on the actual strainer test and we combine those. We come up with an NPSH margin, which is the difference between available and required, and we show that's greater than our total strainer head loss that we got out of our tests. And as an example there, the start of recirculation when we used a temperature of 267 degrees, the containment spray pump had the lowest NPSH margin. It was 5.6 feet. And then compared that to other pumps, but that is still greater than our calculated total strainer head loss of 3.8 feet, which is based on our tests. And that's at that particular temperature at the start of recirc.

CHAIRMAN BANERJEE: That was with chemical effects?

MR. SCHULZ: Yes, this debris head loss here includes the chemicals, yes.

CHAIRMAN BANERJEE: This is just the surrogate chemicals that we approved a long time ago?

MR. SCHULZ: Yes. Per the WCAP methodology, yes. Yes, that's what we used. But we'll talk about that later.

CHAIRMAN BANERJEE: Okay. Was there chemical effects at -- that's John's question.

MR. SCHULZ: Pardon?

CHAIRMAN STETKAR: At that high temperature you aren't getting chemical effects, are you? Again, that's a big conservatism in our analysis, because this NPSH assumes all the debris is there when we start the recirc. So we've taken the highest levels. The coatings have all failed. All the things -- the transport is right there at the sump as soon as we start the pump. So that's a conservatism. We're not looking at time history of NPSH here, so --

(Simultaneous speaking)

CHAIRMAN BANERJEE: You're also doing a viscosity extrapolation, right?

MR. SCHULZ: Correct.

CHAIRMAN BANERJEE: Yes.

MR. SCHULZ: But that is a conservatism here. For the deterministic we take -- break the -- generates this debris and we -- all the other debris loading, it's there. And what -- calculate what our NPSH is. So, that's what --

(Simultaneous speaking)

CHAIRMAN BANERJEE: But everybody does

that.

MR. SCHULZ: Well, some people talk about using time history and other stuff. And we were looking at time history, too, as part of our earlier effort.

CHAIRMAN STETKAR: Originally you were.

MR. SCHULZ: A more realistic approach though. But that got into correlations and it got gray. So now we're trying to use a standard which shows, okay, yes, we're here. Everything here is okay. Up here we'll treat as risk-informed.

CHAIRMAN BANERJEE: No question that this was a conservative approach which other plants have taken as well.

MR. SCHULZ: Okay. Another topic from the guidance report was coatings evaluation. This is how we determined the coatings that we used in our July test. We used a ZOI of 5D based on some testing that Westinghouse did for us in some other plants. That was the basis for our coatings. Ended up as particulates and we had some epoxy chips there. We used tin powder for surrogate. We also used acrylic as a powder and chips as our surrogate.

CHAIRMAN BANERJEE: Maybe the staff can comment on this; or will I hope, on the use of surrogates. There's been quite bit a discussion on what might be the appropriate surrogates. And one of our colleagues, Professor Wallis, has been concerned about this. Do the surrogates that were used for the particulates here meet what we've been doing with the other plants as we've been looking at it, or have we used different surrogates --

(Simultaneous speaking)

MR. SMITH: This is Steve Smith. And I think in this case the surrogates were actually pretty close to -- they actually used acrylic material and they ground that up or made it into chips. A lot of plants had been using silicone carbide or walnut shell flour. This is a more realistic surrogate for what's actually in the plant.

CHAIRMAN BANERJEE: Thanks.

MEMBER SHACK: Still wouldn't address Professor Wallis' concern about size distribution, but --

MR. SMITH: No. Yes, his concern -- and we'll talk to you later at another time about this, but they're doing some testing, some fuel testing that's using varying size distributions and finding some interesting things with that.

MEMBER BLEY: They is who?

MR. SMITH: The PWR Owners Group.

MEMBER BLEY: Oh, okay.

CHAIRMAN BANERJEE: I guess they're going to come in front of us -- when is that, Steve? Is that scheduled for August or October?

MR. SMITH: I don't know if it's been finalized. We've been going back and forth with you guys on what a good date would be. I think it's going to be in the fall.

MR. SCHULZ: Okay. Another element of our -- in the content guide was talk about debris source term. We talk about containment earlier. We're doing inspections to make sure that we have no loose debris and we do it before we declare the containment ready to go when we -- at -- in the outage and also during at-power work. We verify that there's no loose debris also. That's part of what we do.

Design change process looks at any new proposed insulation to make sure it's consistent with what we've done in our analysis of record. We also would look at any new coatings that will be proposed, any additional metal, any additional aluminum that's proposed to be put in containment. We'll look at that. Keep track of that. Look at the impact of what we've done.

CHAIRMAN BANERJEE: Are you trying to

minimize aluminum or -- in containment?

MR. SCHULZ: We have a lot of aluminum in containment. We store our scaffold racks. And that's a lot of aluminum there. We store them inside containment. So we have our aluminum consortium is high compared to maybe some other plants. That was the basis for our --

CHAIRMAN BANERJEE: Your chemical tests?

MR. SCHULZ: -- chemical tests. Yes.

MR. MURRAY: And we have a program that monitors --

(Simultaneous speaking)

MR. SCHULZ: Yes. Oh, yes. Oh, yes, we keep track of that. We monitor how much aluminum we have so we know how much is in there. That way we keep track of how many scaffold racks are in there, too.

So that's our design change process. So we evaluate any impacts that would come along to see how that affects our -- what went into our deterministic calculations for debris reloading.

These are two more elements out of the content guide. This screen modification package. We remove the initial -- that box that was around the -- original box. That was removed and replaced with strainers. You saw the photos there earlier. Each sump now has two 5-module assemblies, a 4-module assembly and a 6-module assembly. So there's 20 modules per sump. And new strainers, they have almost a factor of 12 difference between the square foot between the old design and new design.

CHAIRMAN BANERJEE: That's the free area, right? What is the projected area on the sides?

MR. SCHULZ: Projected area --

CHAIRMAN BANERJEE: So that -- just imagine that you've got a lot of fiber and eventually the area for the discs is not going to be available.

MR. SCHULZ: That would be filled up, yes.

CHAIRMAN BANERJEE: Yes, it would be filled up. So what is the side area?

MR. SCHULZ: I don't know top of my head. We didn't --

CHAIRMAN BANERJEE: You don't fill it up because you don't --

(Simultaneous speaking)

MR. SCHULZ: Yes, we didn't -- that wasn't part of our test. We didn't notice that. We can talk about that when we get the test, too, but we didn't get there. And we didn't get there with our tests, so everything here is okay.

CHAIRMAN BANERJEE: But you never jammed

it completely between the discs with fiber?

MR. SCHULZ: Correct.

CHAIRMAN STETKAR: Wes -- oh, I'm sorry.

CHAIRMAN BANERJEE: No, go ahead. Go ahead. No, I just wanted to be clear what the tests --

CHAIRMAN STETKAR: Well, just to make sure. Perhaps I missed something. Back on your -- and I'm not going to challenge the application here, but back when you were showing us pictures of the installed strainers you said that you put up a barrier to protect them during outages. Do you remove that barrier?

MR. SCHULZ: That's a permanent barrier.

CHAIRMAN BANERJEE: That's permanent?

MEMBER BLEY: Oh, it's permanent?

MR. SCHULZ: Yes.

MEMBER BLEY: I misunderstood.

MR. SCHULZ: I'm sorry. Yes.

CHAIRMAN STETKAR: Thanks.

MR. SCHULZ: Yes, so just some grating that we put on --

(Simultaneous speaking)

CHAIRMAN STETKAR: Yes. No, I --

MR. SCHULZ: -- the plenum to protect it.

CHAIRMAN STETKAR: And I know it's back

away from -- I don't know what -- the distance it's away from the strainers and --

(Simultaneous speaking)

MR. SCHULZ: There's like 18 --

(Simultaneous speaking)

MR. SCHULZ: It varies.

CHAIRMAN STETKAR: Okay.

MR. SCHULZ: So that's physical protection of the strainers.

CHAIRMAN STETKAR: Yes. Okay. Thank you.

MR. SCHULZ: Permanent.

CHAIRMAN BANERJEE: Permanent.

CHAIRMAN BANERJEE: Remind me about the buffer. Which buffer are you using?

MR. SCHULZ: Trisodium phosphate we use. Trisodium phosphate.

So the only modifications we did to the plant for -- in response to the generic letter were insulation, new strainers and we removed -- and subsequently we removed the Marinite insulation and the calcium silicate insulation on the reactor vessel nozzles. So those were the only physical mods that we did inside containment.

Did calculations for the -- show the

structural adequacy of our strainer using -- show it was adequate using the code allowables. So again, there was margin there against the -- using code allowables.

Upstream effects. This is all the standard acceptable methods to look at upstream effects. Doing choke points. Look at the flow -- debris generated inside the steam generator compartments. And then we didn't have any choke points there. And flow can get out and also flow, once it gets out, they can around the secondary shield as well to the sumps. There's pathways there for water. That wasn't an issue at STP. And again, that's something we look at. When we have any proposed modifications, we'll look to make sure we don't impact that.

Downstream effects. We used the guidance and methodology in the Westinghouse WCAP to look at where -- due to debris and blockage, and we didn't have any issues with blockage or weren't aware again based on the standard methodology.

Let's talk about our tests. The test was done in July at Alden Research Lab in Holden, Massachusetts. We used one full-scale module. Took a module from the warehouse and shipped it up to Massachusetts. And that's what we used in the test at maximum flow rate. And again, we scaled this for two trains out of three for our debris loading. And again, we designed the flume channel to emulate the approach velocity and turbulence. And let me show you some pictures here.

Oh, this here's a diagram. You can't read this, but this right here is -- this shows you the flume. It was a narrow flume. And I'll show the photo here. You can see there's a photo with a narrow flume. That's a flume right there with a strainer module in that, but it -- we determined that the width of that flume based on the expected velocity gradients at those points from the strainer based on a CFD analysis that we did.

CHAIRMAN BANERJEE: You're going to talk about the CFD analysis?

MR. SCHULZ: Not right now, no.

CHAIRMAN BANERJEE: But sometime today?

MR. SCHULZ: No. No, we're not. Just that that was done. That's all the details I would know. And we did it to come out with this velocity profile. So it would be representative of what's at the sump strainers.

MR. MURRAY: I think Bruce can add something.

CHAIRMAN BANERJEE: But you ran some computer code to get the velocity --

MR. SCHULZ: Yes.

CHAIRMAN BANERJEE: -- fields in the containment?

MR. SCHULZ: Yes. Bruce's outfit did the --

(Simultaneous speaking)

MR. LETELIER: If I could interject?

MR. SCHULZ: Yes.

MR. LETELIER: This is Bruce Letelier with Alion Science. We ran the flow 3D model of the containment pool velocities. It's very typical to what many of the licensees had done to examine pool transport considerations.

And in regard to one of your earlier questions about the Reynolds number on the approach to the strainer, Wes had not yet emphasized the reduction in the approach velocity that was achieved from the larger strainers. A factor of 12 reduces their entrance velocity to 0.009 feet per second. So we're talking about very low velocities at the face of the strainer. And in fact, some of the higher velocities exist at restrictions in the concrete flow paths, if you will, because when three strainers are drawing the combined flow, there's actually some higher velocities on the containment floor than you actually achieve at the face of the strainer.

CHAIRMAN BANERJEE: That's clear, because of course you got a lot of area at the face of the strainer.

What are the velocities that are outside the strainers? That's the suspension velocities. Are we talking about high Reynolds numbers around the strainers? And what's the length scale you're using for the Reynolds number?

MR. LETELIER: I don't know those velocities off the top of my head, but that information was used to design the cross-section of the flume that you see on the figure.

CHAIRMAN BANERJEE: All right. I mean, if you're going to take credit for that, you need to know what that is. Are you taking any credit for settling on this flume?

MR. SCHULZ: The test was made to be representative. And let me show you the picture here. This is where a strainer is in one of the flume. And the next one has a --

(Simultaneous speaking)

CHAIRMAN BANERJEE: The velocity of the face of the strainer is not relevant from a settling point of view approaching the strainer. We need to know what the velocities were outside and what was the Reynolds number outside.

MR. SCHULZ: Okay. I don't have those particular numbers.

CHAIRMAN BANERJEE: Yes, and because if you're going to take some credit for settling -- I don't know if you did. I mean, Steve, did these guys take credit for settling of the fines or --

MR. SMITH: This is Steve Smith. The test did have settling that occurred. Settling did occur during the test. The velocity in flume was approximately a half a foot per second.

CHAIRMAN BANERJEE: Okay. And that's about the velocities that the CFD shows?

MR. SMITH: That is above the velocities. The velocities don't tend to be an issue in these type of tests. They had to conservatively model the velocity because there's -- in the plant you don't just have a single channel going to the strainer. You have flow coming from every direction. So it was a very conservative -- the velocity ended up being very conservative because they had to take the highest velocity and model that at each point back from the strainer. The problems come in with being able to get the correct amount of turbulence when you reduce the scale.

CHAIRMAN BANERJEE: Yes.

MR. SMITH: This test was a -- believe it or not; it doesn't look like it because it's a very long flume, this test was a relatively wide test. And we didn't have an issue with the turbulence that was generated during the test. Some licensees tried to run a similar test with narrower flumes and lower velocities. And we had a significant issue with them not generating adequate turbulence to be similar to the plant.

CHAIRMAN BANERJEE: So even with half a foot per second because of the length scale there you probably got quite high Reynolds numbers?

MR. SMITH: Yes.

CHAIRMAN BANERJEE: So enough turbulence. Okay. Thanks.

MR. SCHULZ: Here's a picture looking the other way. There was about 40 feet between where we introduced the debris to where the sump strainer module was.

And here's the folks there at Alden putting debris -- introducing debris in the flume there.

And this is what we used for our test based on our 2008 analysis. Fiberglass fines is 192 pounds from latent mostly from the insulation from the break. And then we had some smalls. Particulate debris, we used Microtherm. That was another insulating material we had. We used Marinite. That's Calsil which has been subsequently removed. We had 180 pounds of that. And that's our latent dust and dirt. These are our chemical precipitates that we used during the test. Very conservatively based on 30 days of containment spray to get -- maximize the amount of precipitates. That's the total amount we used -- aluminum oxide hydroxide and calcium phosphate we used in the test. And that's how much our coatings we used. We used zinc powder and acrylic powder and acrylic chips. Those were our surrogates that we used during the test. So this is the test parameters that we used in July. So we're using this as our metric going forward for fiber fines.

Debris prep. Used water jet separation. Particulates. We've got Marinite we used in the test. It's no longer a source of debris in the containment. And we talk about latent debris and use the coating particulates also.

CHAIRMAN BANERJEE: The staff is going to comment on these tests, right, when you talk? Okay.

MR. SCHULZ: Here is our chemical

products. This column here the left is what we used in the test. In the Westinghouse calculation they did it two ways, for a maximum volume and a minimum volume to come up with how much of the three different chemical precipitates. And our test took the maximum value from this calculation. That's what we used. So we bound either case here. So it was very conservative in that sense. And again, as a conservative we used a 30-day for containment spray going, which is very conservative because now we can turn them off in a very short time after the accident. So we get a lot of chemical precipitates using that assumption.

This is our test. We added the particulate and the fiber debris and then we added the chemical debris. This was over the course of three days and again we -- debris head loss during the test. It stabilized around just over nine feet and full flow. And that was a test temperature of 116 degrees. We heated up the water. So we tried to get close to 120 degrees. And then it cooled off because as we were adding debris, there was cold water in those buckets you saw the gentlemen using. But that was our test temperature. And we noticed that approximately half of that head loss was due to the chemical precipitates. So half the test is from the fiber and particulates and the other half is from the chemical precipitates.

CHAIRMAN BANERJEE: Did you also see some saturation of the chemical effect after some additions? Did you add all the chemicals together or --

MR. SCHULZ: No, they were batches, discrete batches.

CHAIRMAN BANERJEE: They were batches? So was there a saturation effect of head loss or --

(Simultaneous speaking)

MR. SCHULZ: Well, we'd add some debris. Head loss would go up. Then we'd wait. Then it would be stable. Then we'd add another batch.

CHAIRMAN BANERJEE: Right. But I'm saying at some point did it make any difference whether you added more chemicals?

MR. SCHULZ: Oh, correct. Sometimes we did not get a instant head loss increase.

CHAIRMAN BANERJEE: Yes, so all the details are in the report?

MR. SCHULZ: Yes. The report, yes. And I think the staff has seen that. I think they asked about that, yes.

MR. MURRAY: Steve, did you want to add something to that right now at the same time that --

MR. SMITH: This is Steve Smith. I think you did get it. The initial chemical additions did make the biggest difference. And the aluminum made a bigger difference than the calcium.

CHAIRMAN BANERJEE: Okay. Thanks.

MR. SCHULZ: So observations from our tests. All the performance goals were met based on -- that we set up. Representative settling allowed fine fiber to arrive at the strainer. So we tried to set up what was prototypical at STP in the flume, so we'd add debris and try to achieve velocity profiles that would be prototypical.

We did have a large quantity of particulate in combination with chemical load. When we looked at the test, there was a small amount of fiber and particulate bed underneath the larger layer of chemical debris. And the conclusion was that we -- it was much less than an eighth of an inch, so we did not do a separate thin-bed test, a test for thin bed. So we thought we achieved that in the way we conducted the test using standard procedures that were acceptable to --

(Simultaneous speaking)

MEMBER BALLINGER: What was the difference between with and without the calcium? Do you know that? Because if you removed the calcium-based insulation, then that contributed to the head loss in this test.

MR. SCHULZ: Right.

MEMBER BALLINGER: But what's the difference between 9.1 feet with it and without it?

MR. SCHULZ: Oh, that was not tested. We did not test that. We just did the one test -- we did one test with the calcium silicate.

MEMBER SHACK: That's a fair amount of it.

MR. SCHULZ: Yes, but the aluminum is probably enough to do the --

(Simultaneous speaking)

CHAIRMAN STETKAR: Because what they said is the aluminum had the biggest numbers.

MR. SCHULZ: Yes, it was our -- well, that's our Marinite calcium silicate, 183 pounds. And then we added 2,000 pound of -- 1,900 pound of coatings and that's our --

MR. LETELIER: Excuse me, Wes. Could I interject?

MR. SCHULZ: Sure, Bruce.

MR. LETELIER: This is Bruce Letelier. I don't want there to be any confusion about the addition of calcium phosphate as a chemical product versus the calcium silicate which is the insulation.

MR. SCHULZ: Okay. I'm sorry.

MR. LETELIER: All right.

MR. SCHULZ: Maybe I was confusing your questions.

MEMBER SHACK: No, I understood that.

MR. MURRAY: Okay. Thanks, Bruce. So again on the timeline when we did the test there was still Marinite in the plant, correct?

MR. SCHULZ: Yes.

MR. MURRAY: And then after that we removed that type of insulation from our plant?

MR. SCHULZ: Yes. I want to show you some of the conservatisms in the chemical portion. We've done some recent testing as part of this risk-informed approach. It would show no evidence of chemical precipitates based on a CHLE test that we've done. We looked at the quantities of chemical surrogate. They're unlikely to occur at STP.

CHAIRMAN BANERJEE: So if you reduce the chemical surrogate in the tests because we added them in batches, we could actually see the effect of reduced chemical surrogates on the results, right?

MR. SCHULZ: That's true. I mean, we haven't measured head loss as we -- as we added we knew what the head loss was as we went along, yes.

CHAIRMAN BANERJEE: Yes, that would be an interesting thing to know. At what point there is a significant decrease. I mean, is it just that you can add very small amounts of chemical and get a large head loss and then the subsequent tests are -- you know, the additions don't have that --

(Simultaneous speaking)

MR. SCHULZ: There is that effect where the initial batch is a big loss. Then subsequent batches are much smaller impacts.

CHAIRMAN BANERJEE: So actually it's amount of that initial addition which has the main effect?

MR. SCHULZ: I think Steve wants to jump in.

MR. SMITH: I was just going to say Paul pointed out you do have a graph in your backup slides of the test that shows when you put the chemicals in.

CHAIRMAN BANERJEE: Well, that would be very nice to see, if you have that.

MR. SMITH: We didn't bring that? We didn't bring the backups? Okay. I can --

CHAIRMAN BANERJEE: It's always dangerous --

(Simultaneous speaking)

MR. SMITH: I have a copy here that I'll

give you.

CHAIRMAN BANERJEE: Okay.

MEMBER SHACK: Are they part of the presentation you gave to the staff in February?

MR. HARRISON: No.

MR. MURRAY: But, Steve, you did say you had a copy?

MR. SMITH: Yes.

MR. SCHULZ: Yes, that will be -- we will submit that, because that was one of the RAIs. We had RAIs from -- as we made our December 2008 submittal, we had RAIs in that and we discussed some of them with the staff informally, but we never responded on the docket. And then we embarked on this risk-informed approached.

CHAIRMAN BANERJEE: Yes, but the only thing --

MR. SCHULZ: So we can go back and answer some of those RAIs formally.

CHAIRMAN BANERJEE: -- our past experience indicates that a little chemical can do a lot of damage to the head loss.

MR. SCHULZ: So we do have that data from our tests.

This is something Janet put together here just to show our margin here. The column on the left is what we tested for total amount of chemicals using the WCAP methodology. For the two different cases, the min and max volumes that's what they calculate and view as a more representative amounts rather -- we used -- based the calcs on more aluminum that we actually had in containments. Some other stuff, too. So actually using representative amounts, it's this much. And then we use -- it goes a risk-informed approached based on our recent testing and we would expect less than this here. So our chemicals that we used in our July 2008 tests are very conservative.

So this is a segue to Ernie, but we're going to have Steve jump in here I guess into this. But this is how we apply our test results. We assume all breaks that can introduce more fiber fine than we actually had in out tests. We relegate those to a bin, a bucket with -- leads to core damage. So we look at all the different scenarios at all the weld locations to see if the fiber is more or less than this ruler. And then we look at this. We use debris generation. Ernie will talk about this, but this is -- and then we have our limits. And then those that exceed the limit go to core damage. Those scenarios there.

MR. MURRAY: Mr. Chairmen, we're at a point where we're planning to transition, so it might be a good opportunity then to --

CHAIRMAN BANERJEE: That's what I was looking at. So the agenda that's in front of us has a discussion of strainer head loss tests through lunch and -- I mean, not speaking during lunch, but until after lunch. And then it ends up with Steve talking from the staff right at the end of all this.

Now, where does this RoverD discussion fit into the agenda as -- you've got the agenda in front of you, right? Or no? Yes. Where are we on this agenda, if I'm trying to maintain sort of time control?

MR. SCHULZ: I would say we're at a good time for a break. When we come back from break, we can as Steve to do his presentation.

CHAIRMAN BANERJEE: Then after we take a break you would have Steve come on after that before you go to Rover? Or do you want to go to Rover and then finish that then?

MR. MURRAY: I would believe it would facilitate best for all of us if Steve came on after -- before we went in. Then we could understand the deterministic basis for Rover as we go in and answer those questions about the test data. I think it gets us in a good grounding point to move forward.

CHAIRMAN BANERJEE: Perfect. So, Steve,

will you be prepared to talk after the break then?

MR. SMITH: I'm prepared.

CHAIRMAN BANERJEE: All right. So we're going to take a break then right now at this point. And I think we'll take a break until 10:15, or do --

MEMBER SHACK: So generous.

CHAIRMAN BANERJEE: -- you want it longer? What?

MEMBER SHACK: So generous.

CHAIRMAN BANERJEE: All right. So we'll take a break until 10:15.

(Whereupon, the above-entitled matter went off the record at 9:57 a.m. and resumed at 10:20 a.m.)

CHAIRMAN BANERJEE: All right. So let's hand it over to you, Steve.

MR. SMITH: Okay. Thank you.

MR. WIDMAYER: Steve, sorry, before you start, I had a request from somebody on the phone that if you could please identify the slide that you're on; And that goes for all the speakers, so they can follow along.

MR. SMITH: Okay. We're going to start out on slide 2.

MR. WIDMAYER: Thank you.

CHAIRMAN BANERJEE: And this is the --

MR. SMITH: Yes, that's the correct one.

CHAIRMAN BANERJEE: -- STP deterministic trainer testing.

MR. SMITH: And, I'm Steve Smith, and Paul Klein is also up here to help make this presentation and answer any questions you have. A lot of this information was already presented by South Texas, so I'm going to go pretty quickly through it. And you guys just ask questions; I'm sure you will, wherever they come up.

So just a little bit of background about STP is they are a high-fiber plant and they don't have very much other insulation material. They have a little bit of micro-coarse insulation in the plant.

They went through that they three trains and two trains are required for operability. And they also mention the strainer face velocity, which is about 0.009 feet per second, which, as we discussed, that's not the same as the velocity of the water flowing to the strainer.

They did make a submittal based on this test in 2008. And I have the ML number there so you can look at it. It has information on the test in there. And one thing I do want to note is that we do have some outstanding RAIs which we quit working on because they changed the way that they were going to address -- they're going to the new RoverD methodology. But a lot of the RAIs that we originally asked on that may still be applicable now that they're going to use the test.

MEMBER BLEY: Do you have to go back through that? I thought I heard them say they were going to respond to those.

MR. SMITH: They are going to respond to the ones that are necessary to --

MEMBER BLEY: Okay.

MR. SMITH: But before we can really make a decision on how we can apply these test results, we need to know the answers to some of these RAIs.

MEMBER BLEY: Sure.

CHAIRMAN BANERJEE: Just a number -- you've got the strainer face velocity there. What is the average velocity onto the sides of the strainer? Not the face, but --

MR. SMITH: I didn't calculate that.

CHAIRMAN BANERJEE: Okay. But it would be quite a bit higher, right?

MR. SMITH: It would be quite a bit higher, yes.

CHAIRMAN BANERJEE: Of the order of half a foot per second?

MR. SMITH: I think --

CHAIRMAN BANERJEE: You did that calculation for us --

MR. SMITH: I did that calculation for you and told you, and we both forgot the answer.

(Laughter)

CHAIRMAN BANERJEE: That was for a different project, right?

MR. SMITH: Maybe it was for a different -- so it's probably a similar --

CHAIRMAN BANERJEE: It wasn't for this.

MR. SMITH: For that one I think it was about a 9:1 ratio, so it may be similar --

CHAIRMAN BANERJEE: Okay.

MR. SMITH: -- for this. So it would be more like 0.1 or a little bit below 0.1.

CHAIRMAN BANERJEE: Okay.

MR. SMITH: This just lists the things that we look at when we're going through. This is basically -- Wes had his No. 6 of head loss and vortex. And this is the things we look at under No. 6, head loss and vortexing area when we're looking at strainer testing.

And this just talks about the test methods that were used. One of the questions that came up was the question about near field settling, and there was only strainer vendor that was using near field settling in their testing, and that was PCI, the test that was being done up at Alden Labs. And these are the things that we talked about with Alden and PCI when they were doing the test, when they were developing the near field testing procedures.

CHAIRMAN BANERJEE: How much of the fibrous material was settling?

MR. SMITH: One thing that we negotiated with them when they were doing the test is that they were to put all the fine debris in first. They were to put the debris in more transportable, then less and less and less. So they put in the fine debris and then the small and then the large. Because what we didn't want to have happen was have some non-prototypical hold up of debris on larger pieces.

So for the fine debris I think that almost all of it would have transported. And then some of the smalls, a significant amount of the small debris actually settled in the flume, and then the large debris really -- it just didn't transport if any was put in. Some tests it was. I don't remember if they put it in their test or not.

CHAIRMAN BANERJEE: As you know, the

concern is mainly with the fiber and the fine particulate debris. And if essentially all of it transports, then -- because I personally didn't have a concern with the larger debris.

MR. SMITH: I would say essentially all of the fine debris transported, because at 0.5 feet per second you're going to get it all there. You know, the tumbling velocity for smalls is like 0.12 feet per second.

CHAIRMAN BANERJEE: Yes.

MR. SMITH: So for fine it's all going to transport. And PCI did some testing in a glass flume that they had, not the plywood flume, the smaller flume, with different degree sizes and showed what was likely to transport and what wasn't. And the fine debris does transport.

CHAIRMAN BANERJEE: Did they also measure how much of it passed through on a pass?

MR. SMITH: We don't have any results from this particular set of testing that was done up at Alden with PCI, but STP did some additional testing down at Texas A&M and they actually did do sampling. A lot of the Alden tests did do sampling of downstream, but it had particulate and fiber in it. And I'm not sure if they were able to characterize what was fiber, what was particulate in those tests. And they may have actually done some tests where they only --

CHAIRMAN BANERJEE: They just weighed what came through?

MR. SMITH: Right. They may have also done some tests where they had fiber only, but I haven't seen any results of those tests.

CHAIRMAN BANERJEE: So in looking at downstream effects like from the core, what would the assumption then in terms of pass-through of the fine fibers and things? I mean, if you don't have the measurement, then you fall back on some other data, right?

MR. SMITH: The staff's fall-back measurement would be that 45 percent of the fiber would go through. And that's based on a test that barely covered the strainer. And so you weren't getting any filtering. So if you have a large amount of fiber, you're going to have a much lower percentage actually going through. So for plants like South Texas, plants that are high-fiber plants, they could not survive with that assumption. They have to do testing to figure out how much fiber is --

CHAIRMAN BANERJEE: Fiber is going through?

MR. SMITH: Right.

CHAIRMAN BANERJEE: But a fall-back position for barely covering, I think that's reasonable.

MR. SMITH: It was based on some testing that was actually done up at Alden, yes.

CHAIRMAN BANERJEE: Yes. Okay.

MR. SMITH: The scaling for this was about two-and-a-half percent of two trains. As Wes said, they have 20 modules per train and this was a two train test and it was one module, so that makes sense. One out of 40 is about 22. So I guess my scaling calculation was correct. And 100 percent of the debris predicted to transport to the strainer was included in the test, but as we talked about some of the larger debris did settle. The smalls and the large debris settled, but not much of the fines.

CHAIRMAN STETKAR: Steve?

MR. SMITH: Yes?

CHAIRMAN STETKAR: Just make sure you -- for the folks on the bridge line, we're on slide 5?

MR. SMITH: I'm sorry. We're on slide 5. Yes, I forgot.

We did observe the test that Wes talked about, which was the July 2008 test. And then there was a test that was previously done in February. The test that was done in February was based on a 17D zone of influence. So that test resulted in excessive head loss before the chemicals even went in. So there were some other differences in the surrogates they used in the test, but we feel that the majority of the difference was just in the amount of fine fiber that got on the strainer and created a bed that was just -- it was just too much for the strainer to be able to handle, for that size strainer.

CHAIRMAN BANERJEE: But we have the results for that, too.

MR. SMITH: There's a trip report, which I've listed there on slide five. And I don't think we have any official results from that because the test didn't really do -- it was not good for them. The results were bad enough that they couldn't use them.

CHAIRMAN BANERJEE: Everything is valuable to understand.

MR. SMITH: Yes. So you can look at that trip report and then if you have questions, I might still remember back that far and be able to answer more questions.

MEMBER BLEY: Can you remember anything about what you mean by "bad?" Was it the head loss was high is all, or was --

MR. SMITH: The head loss, yes --

MEMBER BLEY: -- there something wrong in the process?

MR. SMITH: I remember the head loss got to about 28 feet with just fine fiber being put in and fine particulate. And the pump flow rate had to be reduced significantly in order to be able to continue the test. And then I think it was decided just to stop the test.

CHAIRMAN BANERJEE: All right. So the July tests of course are well documented.

MR. SMITH: The July test is -- and that's included in that --

CHAIRMAN BANERJEE: Yes.

MR. SMITH: -- I think it was on slide 2 we've listed the ML number for the submittal there.

So I'll go to slide 6. This kind of talks about the February test, which we've already talked about. We concluded from that that the amount of fine fibrous debris in conjunction with the particulate debris was just excessive. The strainer just couldn't handle it. So the July 2008 test on slide 7, this lists the differences between the two tests.

So the non-zinc coatings were represented by acrylic paint instead of walnut shell flour. Some of the coatings were added as chips. And Wes had a slide that showed -- I think it was about less than a quarter were added as chips. The biggest difference was the fibrous debris was reduced.

Now I don't know the amounts of fibrous debris because I don't know what was put in the test and I don't have it documented. I might have known when I was there. But the difference between the 7D and the 17D ZOI, the volume is 14 -- it's 14 times bigger for a 17D ZOI. So there was a significantly larger amount of debris in the test that was run in February. So somewhere between the 7D and 17D ZOI amount of debris is the point where you would actually have a strainer failure. You wouldn't be able to -- the strainer wouldn't be able to handle that amount of debris.

So we think it's probably pretty close, Nine point one feet I think is what they came up with. It was about nine feet. We think it's probably pretty close to the 192 pounds that they came up with. It might be a little bit higher than that. It's just without doing a test you can't really tell.

CHAIRMAN BANERJEE: So you were showing us the curves with the chemicals. You don't have that slide to show all that you sent --

MR. KLEIN: That was actually a back-up

slide that STP had sent us. We don't have an electronic copy. But the performance of the strainer in that test was not atypical to what we've seen with other utilities. And the first batch is that chemical precipitate oftentimes produced the most dramatic increase in head loss. And then there appears to be what you had called a saturation effect where the head loss levels off and maybe even decays over time, subsequent batches.

In this case they had run the test overnight and they saw slow decay in the head loss, and then in the morning they saw a jump again with the chemical precipitate addition.

CHAIRMAN BANERJEE: So typically you see the peak and then it sort of goes down and can be attributed to many different effects. And then when you add chemicals again, it will go up and it would stop slowing decay, right? But that's the sort of thing that --

MR. KLEIN: That's the usual type behavior that we've seen, although there's always exceptions.

CHAIRMAN BANERJEE: Yes, there are always exceptions. But also when you add chemicals you sort of -- you reach that peak fairly quickly. And then if you add more chemicals, it almost flattens and it may even come down a little bit.

MR. KLEIN: And that's what their first -- their graph shows that they reached a peak and then when they finished adding the chemicals for the day, they continue to test during the night. There was a decay in head loss overnight until we added more batches in the morning.

CHAIRMAN BANERJEE: Okay.

MR. KLEIN: But their test was conservative both on the quantity of precipitate that was added clearly, but also the type. In their subsequent testing at University of New Mexico, they did not observe that type of amorphous aluminum hydroxide that they used in the flume tests at Alden Lab.

MEMBER SHACK: Well, because they were waiting for it to precipitate out. They weren't doing a Westinghouse-type of test.

MR. KLEIN: Yes, it was --

MEMBER SHACK: Okay.

MR. -- a test much like an ICET-type test where you have a chemical source term and let the environment evolve over time.

MR. SMITH: On slide 8 we have the summary. Kind of just compares the two tests. The July 2008 test was similar to the February test with a little bit of improved methodology and just a reduced ZOI.

CHAIRMAN BANERJEE: But effectively that meant less fiber and less --

(Simultaneous speaking)

MR. SMITH: Yes, less fiber. So the July test, although we accepted the methodology, we wouldn't accept it because it assumed there was a 7D ZOI, which we never -- you know, that was another discussion that we rejected, that 7D ZOI. And we maintain that 17D is the proper ZOI for that.

So even though that test can't be used as a justification for overall plant acceptability, the test was -- it was conducted acceptably and we feel that the test can be used to justify a maximum amount of debris that can be used in the RoverD calculation.

The thing that we don't really have a full understanding of is how the test is going to be applied and how the plant conditions in the test are going to be balanced against each other to show that -- how do they actually reach this 192 pounds of fine fiber in the plant. That's something that we need to examine and understand.

CHAIRMAN BANERJEE: That's a separate issue.

MR. SMITH: That's a separate issue. The

testing was good. The testing was conducted under acceptable methodology. It came up with a good head loss. And they have an actual known limit that was put into that test as far as fine fiber, and that's a good limit for us to use to apply to the RoverD methodology.

MEMBER BLEY: So even though it's a separate issue --

MR. SMITH: Yes.

MEMBER BLEY: -- when they use the RoverD, they're going to have to come up with some of these -- work out on these questions to your satisfaction that right now have a great deal of uncertainty. Where I'm kind of hanging up is they've backed away from what they were doing before on the probabilistic approach to some extent, well, to a major extent to some issues of uncertainties and maybe lack of confidence in some of the models. But here we have those same kind of issues applied to exactly how much debris will be generated. And that's going to have to be worked out.

MR. SMITH: That's what we have to look at. As long as they use the NEI, the staff-approved NEI guidance for how much debris is generated in transport to the strainer, we're not going to have a big problem with it. And there's other things that have to be looked at like erosion, where debris gets held up, how much is eroded from various areas, things like that. As long as they follow the NEI guidance, we're not going to have significant issues with what they're doing.

So the question comes in between how does the NEI guidance and this test and the RoverD -- how do they all mesh together? And that's what we really need to examine.

CHAIRMAN BANERJEE: So I have a slightly different question. Maybe I shouldn't be asking this, but with latent debris of 200 pounds, we know extremely clean plants -- we won't name them here, but we know -- who use the same sort of strainers, right? And they barely make the downstream effects criteria, right? Forget fiber at all. With these strainers they barely make the downstream effect. To add any fiber to it and you assume the same sort of pass-through that we're talking about, how is it that they can get the 15 rems per channel? Or how would anybody be able to do it with these strainers?

MR. SMITH: I don't think we actually have the answer to that yet. I think that's something that we need to get from STP. They had some methodologies they were using to show that there were alternate flow paths for water to get into the core. If they got above 15 grams, the fiber -- that was --

CHAIRMAN BANERJEE: The PWROG is trying to come back to us in October with that.

MR. SMITH: I think the PWROG methodology is a little bit more complex. I think they were just looking at water spilling back over the steam generator tubes. The PWR Owners Group is actually looking at bypass flow paths internal to the reactor. I'm not sure where STP is going to end up with that.

CHAIRMAN BANERJEE: Yes, okay. So I think I was just asking your opinion, because already the latent debris sets a limit more or less. I mean, we've seen this with other plants, very clean plants. I mean, there's no fiber anywhere, right?

MR. SMITH: Right. I agree we need to understand how the in-vessel analysis was done.

CHAIRMAN BANERJEE: Okay. But you haven't looked at that? Well, there's been no submission?

MR. SMITH: There's no submission for RoverD. We were looking at it for the other submission, and I suspect it may be similar. And probably someone, another staff member would be better to talk about it because it's a lot of thermal hydraulic analysis that I didn't look at. I think Glenn Ward, the guys in his branch were looking at that.

CHAIRMAN BANERJEE: Yes, they were looking at that. Lenning did some work as well?

MR. SMITH: He was working on the BWR fuel testing, and he's not anymore. Now Ben Parks is working that.

CHAIRMAN BANERJEE: Okay.

MR. KLEIN: I think that overall though the PWROG is probably confident they can get above that 15-gram limit that's in the current SE. So that remains to be seen as we get into that review, but we've certainly been following the program and observing tests, and they do appear to have a path to get above that 15 grams that is in the current safety evaluation for WCAP 16793.

MR. MURRAY: Mr. Chairman, in thinking about how Stevie came in and helped us, I think Bruce had something like to offer them the clean plant versus fiber discussion.

MR. LETELIER: Only to say that South Texas --

MEMBER WIDMAYER: Name, please?

MR. LETELIER: Bruce Letelier from Alion Science. I only wanted to add that South Texas does have strainer-specific testing for the penetration, the downstream collected mass. And Ernie Kee will present that data in the RoverD discussion.

The staff has not had a chance to review it in detail. That's the reason for the --

CHAIRMAN BANERJEE: Fine. I mean, this is just informational this morning, so that's fine.

MR. SMITH: Yes, we did have a chance to review -- there was a correlation that was developed from testing that was done, and we had a chance to review that. And the way it was implemented in CASA we had some questions about that. So if that methodology is maintained, we'll have to get answers to those questions. We had Southwest Research doing some independent validation of how that testing was implemented in CASA. They just made a different model just to make sure that it looked right. And there's questions about various things associated with that, so we don't have the full story on it.

CHAIRMAN BANERJEE: Right.

MR. SMITH: I will say we were trying to finish up with the strainer testing more quickly than was in the schedule because we thought it would be more interesting for you guys to talk about the newer aspects of RoverD. So I'm glad we were able to finish up a little bit of --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Yes, I think that's fine. I think if we need to get back to you with more questions later in the day, we will. Because we may have some questions following the RoverD.

MR. SMITH: Okay.

CHAIRMAN BANERJEE: So thanks very much and we'll turn it back I guess to you to move forward.

MR. MURRAY: So this is where South Texas is getting back into the presentation. We'll start at slide No. 44.

So, Ernie, if you could, when you move to a slide, mention the slide number, please, sir.

MR. KEE: Yes, sir. And one other point is 64 should be ignored. That's not the right total count.

We are on slide 44 and the objective of this next series of slides is to over what we call risk over deterministic, or RoverD test-based debris risk assessment.

Just to go over some of the motivation for this approach, and I think it's probably been mentioned earlier, but I'm just going to cover that again. In our work over the last couple, three years we've struggled with the epistemic uncertainty that is engendered in correlations, especially new ones. And the review has taken a lot of time on the part of the staff and so forth because of the complexity, as has been acknowledged earlier. And so we wanted to reduce some of that complexity, and we feel like that our approach we're taking now in RoverD should make the analysis far more transparent.

So that leads to a scope reduction on the part of the staff and it also helps out other people that are involved in the pilot activity. We used deterministic test data to screen out many scenarios.

MEMBER SCHULTZ: Can I say this differently, Ernie, because what we just heard is there was an intention to demonstrate through the February testing that all was well and good, but the testing that was done in July was based upon the smaller zone of influence evaluation. And so, you also want to find a way in which to use that information in the overall evaluation approach without going into the complexity of correlations. Is that the case or --

MR. KEE: So, I guess the notion is that we've -- as Wes described, we created in July of 2008 a pretty challenging test with a lot of chemicals, a lot of precipitates, even some that we don't have in the plant today, excessive amounts of corroding material like aluminum, running the containment spray much longer than we ever believe we would, so on and so forth.

So we've challenged the strainer like that. And we want to understand what kind of -- out in the tails, if you will, how much risk is remaining, acknowledging as well that in our testing that we've done over the last couple, three years, we do not see significant production of the kinds of materials that cause the most head loss. As Wes pointed out, approximately half of the head loss that we experience is coming from the chemicals that were added, which are more than we would ever expect to see.

MR. MURRAY: So let me add, your characterization, I captured it as accurate the way you were applying it. I think you had it characterized. Ernie's taking us more in depth in the details.

MEMBER SCHULTZ: Which we'll get to in --

MR. MURRAY: Right, we'll get to.

MEMBER SCHULTZ: -- the application.

MR. MURRAY: But I think the way you entered it was, yes, we're looking for a way to use that information and bring it into the process.

CHAIRMAN BANERJEE: But from what you said, I understood, maybe wrongly, that all the scenarios that produce up to the testing limit you can handle in a sense deterministically because it doesn't matter; it will cause no problems. So you essentially forget those scenarios. I think that's the way I look at it. Maybe not exactly, but what's important are the scenarios that will lead to material coming through the strainers above your 193 pounds or whatever.

MR. HARRISON: Right, we're using fine fibrous debris as the --

CHAIRMAN BANERJEE: Yes, so --

MR. HARRISON: -- metric.

CHAIRMAN BANERJEE: And those are the scenarios that you're going to look at the risk significance of the impact to risk.

MR. KEE: Correct.

CHAIRMAN BANERJEE: Is that in broad terms what you're trying to do?

MR. KEE: Correct.

CHAIRMAN BANERJEE: Okay. Is that consistent with what you understand, too, John?

CHAIRMAN STETKAR: Yes, and your hope is that the uncertainties in the use of this test data can be resolved more expeditiously than you could resolve the uncertainties in the models that you'd developed previously.

MR. KEE: That's correct. Or another way to put it is by applying very challenging conditions we believe that we've bounded these uncertainties that have been kind of plaguing our analysis over the last period of time.

And another point is by doing this we are putting things kind of in a more familiar setting. Like for example, fuel testing has these limits that have been set. The only nuance is that we're examining now the risk of that. It may be beyond the uncertainty that's been included in the test conduct.

CHAIRMAN BANERJEE: Yes, so you don't know the uncertainties associated with these tests because that would require -- yes, so you just sort of said that these are pretty bounding tests in terms of chemical additions, whatever. And I think the staff and ACRS has looked at a lot of these tests in the past and we understand that these are bounding assumptions for the amounts of material we're talking about. But if you get more than that, of course you're in a different sort of situation where I guess you have to find out --

(Simultaneous speaking)

MEMBER SHACK: This is bullet three.

CHAIRMAN BANERJEE: Yes.

MR. KEE: So we talked about -- recall that we never expect to see any of these kinds of materials in close LOCA sump water at South Texas. And that's based on testing. So we've actually kind of looked at what is the -- as I mentioned, the amount of uncertainty that's captured in these tests is quite a significant amount.

MR. MURRAY: So what we've done is we've not ignored any of the learnings we've had over the years. We've continued to use those and understand where those conservatisms are because of previous tests. But as you see as we go through this, we're not crediting so much those -- we know they're there. We've seen them and proved them, but we're staying focused on what was the results of the 2008 test and what is the debris generated in the different locations and does that exceed? So that's the focus. We have learned a lot and we've not ignored what we've learned in that going through this process. We're just trying to keep it in a -- answering the deterministic questions yes/no, does it generate more than we had tests results that can support. We leave these conservatisms in, these chemical effects in, these results from 2008 tests into the equation and take it through that process. And I think that's what we'll show you as we go through this.

CHAIRMAN BANERJEE: All right. Let's move on.

MR. KEE: Yes, so by assumption we relegate all the scenarios that would occur that have more than the amount of fine debris tested to core damage. And we've already said that the deterministic test challenges the strainer performance.

MR. MURRAY: So we're on slide 46.

MR. KEE: Yes, slide 46. Sorry.

MEMBER BLEY: Are you going to talk more in your later slides about the second box here where you --

MR. KEE: The top box or the bottom box?

MEMBER BLEY: It starts at the top, deterministic test. The next box is examine the individual break locations and equivalent fines. And then are the fines above or below what you had in that test? That second box is kind of a crucial one, how you partition these scenarios. And it seems as if it's one that you and the staff haven't quite agreed on how that partition ought to go because that's linked to your zone of influence. And that seems to be a place that you're not in agreement yet.

The place I'm wondering is when you get all done with this and you reach agreement on that box, what if the ones that go up here to guaranteed core damage, the frequency of that bunch is higher than you wanted it to be.

MR. KEE: I think that would be

problematic.

MR. HARRISON: We need to go back for just a second. You said this is with regard to the zone of influence. Ernie can elaborate on it, but the break -- or excuse me, the testing assumed a load is based on a 7D. What it did is it gives us a baseline quantity --

MEMBER BLEY: Yes.

MR. HARRISON: -- of material.

MEMBER BLEY: Yes.

MR. HARRISON: And when we go do this evaluation that's in this second box, all the debris generated in that evaluation was based on using a 17D zone of influence.

MEMBER BLEY: Oh, it is?

MR. HARRISON: So all we're doing is comparing it to --

MEMBER BLEY: Okay.

MR. HARRISON: -- the total amount of material that was in the test --

MEMBER BLEY: Okay.

MR. HARRISON: -- that's really the important value at that point.

MR. KEE: So let me address that --

MEMBER BLEY: Okay. So that helps.

MR. KEE: -- concern, which is how are we certain, I think you're asking, that we get the right amount of debris in the sump that we're doing this determination on?

MEMBER BLEY: Yes, are you getting an amount you can agree with the staff?

MR. KEE: Agree on. And so I think we presented in February initial results, and we didn't have agreement, as a matter of fact, with -- but that with some additional information that's been provided and worked through I believe we're in agreement now, or very close. That's one point.

And the second point is the way we do this work of determining the amount of debris that arrives in the sump follows the guidance that is common to everyone in terms of the logic trees and the ZOI --

MEMBER BLEY: The NEI guidance.

MR. KEE: -- that NEI has published and the staff's looked at. So those are very -- there's no funny -- there's no uncertainty in there. It's a straight up calculation. Here's the debris generated, here's the transport logic, here's what arrives in the sump, here's what's eroded, here's what's in the latent fiber, and so on and so forth. So that methodology with which we arrive at the amount of debris in the sump is familiar and is similar to what was done back in 2008 with the exception of the size of the ZOI. But that's just a nuance of the detail.

MR. MURRAY: So clarifying one item is that what the staff is seeing in the RAI, will see in the RAI responses; we're currently taking through signature process, will be that piece that they're anxious to see on how do you determine the amount of debris in the different areas? So that's where that information --

MEMBER BLEY: And if I understand where you're headed with RoverD here, the last vestige of risk-informed is a calculation of the frequency of these scenarios that go to greater than 182 pounds, or whatever it is.

MR. KEE: More or less, yes.

MEMBER BLEY: Okay.

MR. MURRAY: So we're probably four or five slides ahead. Mr. Chairman, you had a question?

CHAIRMAN BANERJEE: No, I was just saying that the issues that you're dealing with, at least in the opening remarks that were made, have to do with getting clarification with the CAD diagram and so on so that you can get good estimates of the effect of the 17 ZOI on different breaks in different locations of different sizes, right? So that you can come to some agreement about how much debris is generated in each of the scenarios you are examining.

MR. MURRAY: That's a fair summary.

CHAIRMAN BANERJEE: But you're using, if I understood it, always the 17 ZOI in all cases?

MR. KEE: For low-density fiber, yes.

CHAIRMAN BANERJEE: For everything you've using it, but now you're trying to look at different welds and different sizes and how much debris is going to be generated, but within the 17 ZOI.

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: That's what you're doing right now?

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: And you're examining different break locations, different break sizes, whatever it is.

MR. KEE: Again, this is a familiar methodology.

CHAIRMAN BANERJEE: Yes.

MR. KEE: When you look to the worst location, you have to do this kind of exercise.

CHAIRMAN BANERJEE: And so then you are just binning it into two. One is if the debris is below the July testing limit, then that's deterministic. If it is above, then you have to do some fancy footwork on that.

MR. KEE: Exactly.

CHAIRMAN BANERJEE: Okay.

MR. KEE: So maybe we've exhausted this slide.

CHAIRMAN BANERJEE: Yes.

MR. KEE: We can move to No. 47.

CHAIRMAN BANERJEE: That's pretty clear. And Dennis' question was related to the second box, exactly what you're doing. And that we will see ultimately once the staff has pored over it and what their recommendation --

(Simultaneous speaking)

MR. KEE: So we're on slide No. 47 then. So one kind of a bit of a nuance here now is that we use this CASA Grande code to -- I saw exhaustively -- I'm speaking of hundreds of thousands of samples of break size, orientation and so forth, which we've gone over in the February discussion, so that at each location the objective is to find out for all these thousands of scenarios what amount of debris at what break size arrives in the sump, the amount of fine debris generated and transported for all these.

CHAIRMAN BANERJEE: So you don't assume

that all the latent debris always gets to the sump?

MR. KEE: We do --

CHAIRMAN BANERJEE: I mean, all 200 pounds?

MR. KEE: -- assume that the 15 -- is it 15 percent?

CHAIRMAN BANERJEE: Fifteen pounds of fiber.

MR. SCHULZ: Fifteen percent. Thirty pounds.

MR. KEE: Thirty pounds is automatically put in every time and --

CHAIRMAN BANERJEE: Yes, so it doesn't matter. This is size independent. Doesn't matter.

MR. KEE: And the eroded amount is put in instantaneously. So that's a conservatism, if you will. And what these sub-bullets say. We sum up all --

CHAIRMAN BANERJEE: The fine debris from the latent debris being instantaneously put in is fine. I don't understand what you mean, the amount of debris from fiber erosion.

MR. KEE: Sure.

CHAIRMAN BANERJEE: What do you mean by that?

MR. KEE: Yes, sir. So as water from the break or potentially containment spray washes over -- or I suppose it can even take place in the smalls that are down in the sump. These are all analyzed known kind of relationships that you assign. And I said wrongly last time -- I think it's roughly 10 percent of the larges and smalls; Bruce, correct if I'm -- are assigned to fine debris, erode to fine debris.

CHAIRMAN BANERJEE: Where is this erosion taking place?

MR. KEE: Everywhere throughout the plant and wherever there's large -- so some of the destroyed insulation, if you will, is just big chunks. And they stay in place. They don't transport.

MR. HARRISON: I was going to say, if it helps, Wes touched on that when he was talking about what he put in for his deterministic test. I think it was one percent of the fibrous, or erosion. So you're carrying that assumption through to apply here as well so it's consistent with --

MEMBER SHACK: Stuff just breaks up after you hit it with the initial blast, it generates fines. Some of the smaller chunks then break up later producing more fines. So they're totaling up the amount of fines.

MR. KEE: We just put that in. And we sum it all up. That's what we --

CHAIRMAN BANERJEE: There's some assumption you make there. That's what I'm after.

MEMBER SHACK: That comes from the NEI document, so it's all agreed upon.

CHAIRMAN BANERJEE: Yes. What is that number?

MEMBER SHACK: Right or wrong.

CHAIRMAN BANERJEE: Is that one percent or --

MR. KEE: I'm sorry, is it one?

MR. SCHULZ: One percent.

CHAIRMAN BANERJEE: All right.

MR. SCHULZ: And Ernie pointed out that's instantaneous, too. It goes over time. We assume it all goes in.

MR. KEE: Let's dwell on this for just a moment, because there was a lot of discussion about, well, how much of this that got put in the test -- how much of that fine stuff got on the strainer, right? I mean, did it settle? Here we say it all gets there. So there's no question about transport. That's gone. We put it and we say it all hits.

MR. LETELIER: If I could --

MR. KEE: We're looking for that 191.78

that was tested.

MR. LETELIER: If I could clarify. The source term is what's introduced to the test and it's also what's introduced to the containment pool.

MR. KEE: That's correct.

MR. LETELIER: So we have an equal comparison of our scenarios to the initial condition of the test. We're counting on the test to provide representative transport, representative settling.

MR. KEE: So the point is we're not assuming any --

CHAIRMAN BANERJEE: Well, in the test there's a chance for settling, but effectively they said -- they call it the turbulence level that would -- settling of fines.

MR. KEE: Yes. So maybe I mis-spoke there.

MR. MURRAY: Did Bruce's explanation help? I want to make sure we're as clear as we --

(Simultaneous speaking)

CHAIRMAN BANERJEE: I think the clarification is you introduced that amount in the tests, into the test flume. And then whatever is transported gets transported.

MR. KEE: And then at each location where we've looked at thousands of samples at each location we find out if the amount of fine fiber transported to the sump is more than was tested. So if not, then that amount will be a double-ended guillotine break. When we look at each location, if it's a double-ended guillotine break. And we say basically it's a deterministic category and what's the margin to the 192 pounds at that location? And so for all those locations we know what the margin is, how much remains below the tested amount. And if it's more than the tested amount, we look for the smallest break size. From all the samples we look for the smallest break size that exceeded the tested amount, and that's thrown into a risk-informed category. So if that's clear. So we look for the smallest break that exceeds the tested amount for risk-informed. So there was some --

MEMBER SHACK: Well --

MR. HARRISON: That establishes the maximum risk, or the maximum frequency of the break size.

MEMBER SHACK: But you include all of the breaks above that size.

MR. HARRISON: Yes.

MEMBER SHACK: Right. That's what stopped me there a little bit.

MR. KEE: So we're looking --

MEMBER SHACK: It's the cumulative frequency above that break size that you're looking at.

MR. HARRISON: Yes.

MR. KEE: Exactly.

(Off microphone comment)

MEMBER SHACK: Yes, well, that's a different question, but it is important to have the whole cumulative frequency, which is what they've got.

MR. KEE: It's possible that there are some angles and sizes that would not exceed, that are larger than the smallest break size, right? It's possible. It's not very likely. But by finding the smallest one and then relegating all the rest into that category, then would take care of all that. That's a simplification that we make.

MEMBER SCHULTZ: To say it in reverse, if you break the pipe and pipe size and you don't create enough debris, or you create low debris so that you can fit into the deterministic category, you're done.

MR. KEE: That's correct.

MEMBER SCHULTZ: If it breaks and you create more debris, then you have the opportunity to go down in size and figure out the smallest size that also will pass deterministically.

MR. KEE: Yes, sir.

MEMBER SCHULTZ: And the rest of it you have to put into the risk-informed category, the larger sizes.

MR. KEE: Precisely.

MEMBER SCHULTZ: Okay.

MR. KEE: So moving to slide 48 then, there is some fair amount of discussion about how many trains were tested and what about the ones that aren't tested and so on and so forth? So the test that we performed in 2008, as Wes already described, looked at two trains with kind of the maximum condition, the deterministic basis for those kind of tests which has full flow through those strainers. And as Wes described, South Texas Project has three independent trains, so there's really three strainer trains that could be involved. As we know from our risk analysis, the most likely condition is all three trains start and run. And if they do, the containment spray pump on one of those three will be secured as a conditional action step in the emergency operating procedures by the operators shortly after the initiation of the event, assumingly actually containment spray of nine-and-a-half pounds.

Okay. And then so the two-train scenario actually, if we think about it for a moment, bounds the three-train case the mostly likely one. There will be less debris, probably less even than a thin bed on all three trains than the two trains that were tested. And additionally, on one of those trains there will be less head loss because there will be less flow through that, almost 40 percent less flow because the containment spray pump is quite a large draw. It is similar to the low-head injection pump in terms of flow rate.

So on those two or three-train scenarios in the deterministic and risk-informed categories 628 Class 1 weld locations that were analyzed. Forty-five locations fell into the risk-informed category. Five hundred and eighty-three were in the deterministic category. So there's 583 double-ended guillotine breaks that don't exceed the amount of fiber that we tested. And so we can see that this -- instead of examining 628 welds, we now will examine 45 for --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Just a question. This is all related to the sump, right? So it can be that for scenarios where you have less fiber generated, more fiber may possibly pass through because the fiber bed itself has a filtering effect. So the downstream effects could actually be more severe in some cases where a fiber bed doesn't do any filtering.

MR. KEE: That is a possibility. We examine that.

CHAIRMAN BANERJEE: So you have a relationship related to how much fiber passes through as a function of the amount of fiber generated?

MR. KEE: We actually have measure test data for an actual strainer module that we conducted at all the labs.

CHAIRMAN BANERJEE: You have data on the pass-through --

(Simultaneous speaking)

MR. KEE: And we'll show that later.

CHAIRMAN BANERJEE: Okay. So you're covering that aspect of it?

MR. KEE: Correct.

CHAIRMAN BANERJEE: And I want to point out that the single-train scenarios, while they're very unlikely, like on the order of total frequency, it's something like four or five to the minus eight per year, reactor-year. We still include those and add the risk to this analysis.

CHAIRMAN STETKAR: Ernie, tell me more about this single train, because ultimately this comes down to a Reg. Guide 1.174 delta CDF and delta LERF calculation. The baseline risk for the South Texas

Project, my recollection; correct me if I'm wrong, is based on success criteria that says any one of the three trains gives you success. Is that correct?

MR. KEE: It's possible. Not all of them do.

David, is it 60/40?

MR. JOHNSON: David Johnson, ABS. Yes, in a deterministic world one train is successful, but if one train is in a broken loop, for example, it's not successful. Okay? So, yes, only about 40 percent of the -- or 60 percent of the single-train cases are possible for success. We included --

(Simultaneous speaking)

CHAIRMAN STETKAR: Okay. So we're talking roughly a factor of two?

MR. JOHNSON: Yes.

CHAIRMAN STETKAR: So the baseline risk with in about a factor of two or so, is determined by single train? What I'm trying to get to is if the test data are developed based on a two-train running loading condition, and the baseline risk is determined largely by a single train success criterion, are you measuring a delta with too little fiber on your strainers because any condition in the current risk model with two trains running is guaranteed success?

MR. JOHNSON: I think this, Ernie --

(Simultaneous speaking)

CHAIRMAN STETKAR: Sixty percent of the time when you got one train running it's guaranteed success.

MR. JOHNSON: Yes, this David. I would object to the "guaranteed" word here. There's determined to be success.

CHAIRMAN STETKAR: Quantified in the PRA. The baseline. I don't care, 10 to the minus X has that contribution to it, and now you're measuring a delta on 10 to the minus X.

MR. JOHNSON: Let him get to the point where how he's calculating the delta.

CHAIRMAN STETKAR: Okay.

MR. KEE: Yes, I think we --

(Simultaneous speaking)

MEMBER SHACK: Could I just go back to Sanjoy's question again? Everything I've seen here seems to say that you use that fiber, 192 pounds, as the single criterion for binning these things as either risk-informed or deterministic. But there's some question -- so I mean, it somehow seems to me an implicit assumption somewhere in your model that everything that meets the 192 pounds is also going to meet the in-core situation.

MR. KEE: Actually, it's explicitly shown.

MEMBER SHACK: It's explicitly shown?

MR. KEE: Yes.

MEMBER SHACK: Okay. So his scenario where it's worse you're saying is not correct? It's always better to have less fiber in your model?

MR. KEE: Including the carryover test data.

MR. KEE: That's correct.

MEMBER SHACK: I mean, certainly that's true for the strainer. The question is whether it's true for the in-core results.

CHAIRMAN BANERJEE: What passes through the strainer?

MEMBER SHACK: You don't have the filtering effect of the bed. You need to get more pass-through and you --

MR. KEE: There are several questions that have to be answered, right?

CHAIRMAN BANERJEE: Yes, we'll see what you've got there. You're going to talk about that, right, at some point, or --

MR. KEE: Yes, sir, we can talk even further --

CHAIRMAN BANERJEE: -- downstream effects.

MR. KEE: -- about some of these downstream --

MEMBER SHACK: It's true that there's a single criterion, which is the amount of fine produced.

MR. KEE: No.

MEMBER SHACK: No?

MR. KEE: It's not totally true.

MEMBER SHACK: It's not totally true? Okay.

MR. KEE: There's --

(Simultaneous speaking)

MR. KEE: Well, let's clarify that the amount of fiber fines --

MEMBER SHACK: Is important.

MR. KEE: -- is important in terms of assigning a category, either risk-informed or deterministic. After that you need to make sure other things are satisfied.

MEMBER SHACK: Okay.

MR. KEE: So Wes has already pointed out all the things that were satisfied for the test that was done. It had 192. But in the risk-informed category, right, we have to look at other things. So we'll talk about that.

CHAIRMAN BANERJEE: I guess with the 192, are there other qualifications that you then examine to see if it's -- truly 100 qualifies or not, like downstream effects and --

MR. KEE: Of course the test was conducted with 192 pounds of fine fiber, but that's kind of a simplification of the test condition we had, all these other materials that were included in the test. So you have to -- well, you don't have to, but it's I think useful to continue to think in terms of, well, that's how much fiber transported to the strainer.

Again, this should be familiar. Like in WCAP 16793, now it turns out how much fiber is on the bottom of the fuel? Oh, that's 15 grams for fuel assembly. Above that you fail. Below that you're okay for cooling. This is a very similar notion. We looked at that. But those tests included chemical effects. Particulates were all thrown in. All the same kinds of things that we've done here were done there.

So that's the same kind of context. They find some kind of a performance index, which I think has kind of been settled out in regulatory thinking or -- that the fiber is the thing to look for. The transportable fiber is the thing we need to be careful about. So then tests for the other materials in a deterministic scope.

MR. MURRAY: So I wanted to go back to when we were looking at that box of concern, because that is the box that comes into the deterministic versus probabilistic that was on page 46. Now, correct me if I'm wrong as I say this, but I think I'm correct. There are two criteria we look at on a deterministic box, not just the performance of the head for the pumps, but we also look at the in-core effects as a pass on that, right? So I want to make sure that's clear. So that's the other part of it. We have to look at both to define is there a failure on in-core effects or is there a failure on the sump? I wanted to make sure we were clear on that.

MEMBER SHACK: Okay. So there's two criterion --

MR. MURRAY: Really you have to have a pass/pass to get the yes line. Okay? So in the way we treat it I think we've looked at that. Bruce and Ernie, am I incorrect with that?

MR. KEE: No, we'll get to that --

MR. MURRAY: Okay.

MR. KEE: -- to show that --

MR. MURRAY: But I think that helps is move

--

(Simultaneous speaking)

MR. KEE: -- kind of at a higher level.

CHAIRMAN BANERJEE: Well, it would be helpful to make this into -- depending on the procedure you use into two of them, because what you're saying it has to pass one criteria first and then it has to pass the other. And to pass the other it's not obvious that 193, or whatever that number is, will pass that other criteria.

MR. KEE: That's clear.

MEMBER SCHULTZ: So the simple chart is not as simple as it looked.

MR. KEE: It's almost that simple.

MEMBER SCHULTZ: Well, yes, but you're saying there are two criteria to pass the deterministic block. One is listed and one is not.

MR. MURRAY: I think I'm using the right logic here. It's not an or gate to pass. It's an and gate to pass. But you have to have success on the strainer and success on the core to be able to take it right through to deterministic. Is that correct? So that's another way of saying it.

CHAIRMAN BANERJEE: Yes, so you could generate less fiber, in theory at least; I don't know, I haven't seen your data, and pass one of those, but not pass the other one?

MR. KEE: That may be possible.

MR. MURRAY: Yes, you could.

CHAIRMAN BANERJEE: Yes.

MR. MURRAY: You could is the right answer.

CHAIRMAN BANERJEE: Yes. All right. We need to go into this of course when this really comes in front of us in infinite detail.

MR. KEE: I mean, we have that in mind. We're looking at that. So that's a consideration in the results.

So, should we move to the next slide, No. 49? So we have the big picture. And Wes eloquently described all the considerations that went into the deterministic part of these analysis. And now we're looking at the R part, if you will. So the RoverD, the R, the risk.

And on this figure you see we have the risk-informed block. And that block requires or asks for these scenarios which we've talked about that are screened by the amount of fine fiber that arrives in the sump to be evaluated for risk. That requires the probabilistic risk assessment, the model of record that we have in place. And Reg. Guide 1.174 guidance is what we've always used. And all the scenarios that have arrived in the risk box are relegated to failure. And this is in the interest of reducing complexity and scope of review.

So we think about this, the risk, as basically conceptually like an initiating event frequency that has a likelihood of failure, if you will, of one. All these scenarios go to core damage, so that's the increase in risk due to the concerns associated with GSI-191. And we determine a weighted frequency for that. It's nominally centered around NUREG-1829.

We look at the delta CDF initially as a basic pass. Is it in Region III of the Reg. Guide 1.174 guidance or not? And if it is, then we move onto check the probabilistic risk assessment to assess core damage frequency and LERF. Those two numbers from the PRA model of record orient you on the -- I always get these confused -- it's either the abscissa or the -- I believe it's the abscissa of the phase planes of delta CDF-CDF and LERF and LERF. These are very familiar. And as long as you have appropriate levels of CDF and LERF and double CDF and double LERF, then you can make a determination of where you are in Region III-123. And we find actually that we're in Region III. And so the debris mitigation is acceptable at a very high level. That's the whole picture on this diagram.

So moving to slide 50 --

MR. JOHNSON: Ernie, if I could -- this is David Johnson. If I could get back to Mr. Stetkar's question, the RoverD approach effectively decouples the calculation of the deltas from the baseline. Okay? So we don't use the PRA to calculate the deltas of CDF or LERF.

CHAIRMAN STETKAR: You do though to the extent that -- let me get back to -- suppose I had one and only one train running. Could I get into trouble with less than 192 pounds total release --

MR. JOHNSON: Yes.

CHAIRMAN STETKAR: -- if I had -- okay. You're not doing that calculation, though.

MR. KEE: Actually I am.

CHAIRMAN STETKAR: You are? Okay. I want to understand how you're doing that, because that's --

MR. KEE: Yes, okay. We --

CHAIRMAN STETKAR: -- that gets back to -- as long you're doing the delta okay for that case. I understand how all the other deltas are done.

MR. KEE: Yes, sir. Yes, we'll -- and if

you have further questions when we get to --

CHAIRMAN STETKAR: For that lower debris release, if you will.

MR. KEE: So we'll go to slide 50. And this has probably been made clear earlier, that we use the deterministic strainer test data and we note the amount of fine debris, debris from the CASA calculation that uses accepted methods, acknowledging we still are working through and making sure that's understood jointly with the staff.

And then we're using, as I mentioned already, deterministic core fiber loading data. That means the 15 grams for fuel assembly which has considered with it, as I mentioned, chemical effects of debris, particulate debris and so on and so forth. But what's important here is -- maybe I should mention this is also somewhat of a conservatism since it's double counted, the chemicals and the particulate are double counted here.

But nevertheless, we use 15 grams for fuel assembly as a core cooling limit and we ensure that the amount that's -- this is a question that's been asked, that the amount in the deterministic -- below that deterministic threshold collected on the core is less than the core cooling limit. And we'll talk about the fact that we need to think in two different regimes here, cold leg break and hot leg break.

I think we've said this. Obtain the smallest break size from CASA generation and transport methodology at each weld location that produces more fine fiber in the sump in the strainer test used. They're the risk-informed scenarios. And then we derive a total failure frequency based on the smallest break sizes from NUREG-1829 to assign to delta CDF. Notionally this is an initiating event frequency -- is the way we think about it. Then we check to make sure delta CDF is in Region III of Reg Guide 1.174. Then we do the other checks, delta LERF-LERF is in Region III. And defense-in-depth and safety margin requirements, all that has to be in that as well. I we've responded to some of those kinds of discussions earlier, but we're also looking at all that in the context of RoverD.

CHAIRMAN STETKAR: Ernie, are you going to talk a little bit more; I don't think you are, about the -- you said you used the LOCA frequencies from NUREG-1829. Back in our last meeting we had some questions about the method that was being used at that time to interpolate the data from NUREG-1829 versus other schemes that might apply. And at that time that was only one element of the entire picture. So is it important? Well, it's equally important with many other elements. My sense is it becomes much more important now because this is essentially your only part of the risk information, the quantification of the frequency as a function of break size on the uncertainty in that frequency now determines your delta CDF, and to a lesser extent your delta LERF for reasons we'll get to. But are you still retaining that former interpolation methodology with the -- whatever they are, the Johnson probability distributions and so forth?

MR. KEE: Okay. We're not.

CHAIRMAN STETKAR: You're not? Okay.

MR. KEE: We have --

CHAIRMAN STETKAR: That's good enough for now.

MR. KEE: We've retained the linear interpolation.

CHAIRMAN STETKAR: You have retained the linear-linear interpolation?

MR. KEE: Yes, but we're agnostic on that point. I mean, I guess the point is we're --scenario

CHAIRMAN STETKAR: It depends on the break size range that becomes important, but I mean, how important that interpolation methodology is depends on where you are --

MR. KEE: Correct. And so, uniformly --

CHAIRMAN STETKAR: Frequent breaks, if I call them that.

MR. KEE: Yes, sir. And so my observation is, because we've studied this to some extent, that if you use log or log-log interpolation, the frequencies realized would be lower, uniformly lower than using log-linear, or linear-linear.

CHAIRMAN STETKAR: As I said, it kind of depends on where those breaks are that you're targeting.

MR. KEE: I might mention that all the breaks -- so all our breaks are large, very large, that result in this kind of loading on the strainer. I don't know if that helps.

CHAIRMAN STETKAR: I'll think about it. But you are retaining the linear to linear?

MR. KEE: Yes.

CHAIRMAN STETKAR: Your original linear?

MR. KEE: In all the results I show here --

CHAIRMAN STETKAR: Okay.

MR. KEE: -- we used linear-linear interpolation.

CHAIRMAN STETKAR: Okay. Thanks.

That's good enough to help for now. Thank you.

MR. KEE: So moving to slide 51, I just want to review -- and I think we've seen this before, but as Wes mentioned, there's three trains of emergency core cooling that's also piggybacked, if you will, with containment spray. So shown on the figure on the left is the view of that system in the containment. What is showing is the three strainers in the lower left of that figure. And so here we see the three strainers and, as I said, there's a mass that collects, a mass of fiber that collects on these strainers and we have a pool here that has a mass of fiber in it, and a volume, okay?

And you can follow any one of these -- let's just follow the A train of total flow through the strainer. So that's a low-head pump, a high-head pump and a containment spray pump, as Wes mentioned. And some of that flow notionally; we don't have the pump shown, goes up to containment spray and comes right back to the sump. So it goes through the strainer, goes up and right back.

Some of the flow however that -- the flow coming from the high-head/low-head pumps goes directly into the reactor coolant system. And if unfortunately that single train were to be on this location right here, it would just go straight out the break. That's why it's such a low probability of success. Otherwise, it would go in one of these three legs. I think that's all we can talk about there.

And then on the right side of the figure we have a notional representation of the flows through the reactor vessel. And you see that the flow split shown of the ECCS that goes here into the legs, we call that flow split. The amount that goes to spray is gamma, so the one line that's gamma makes it into the RCS.

Well, we're talking about cold leg breaks, and what happens in cold leg breaks is the -- a lot of water because we pump in a heck of a lot water. A lot of it just goes right back out the breaks and just gets recirculated and goes around through the strainers again and again. But some of it, luckily, nicely -- we shouldn't say luckily, but on purpose goes through the core to cool it. And this is where we're talking about the 15 grams for fuel assembly. If it exceeds that amount, we can no longer cool the core.

So in the past something that we've abandoned -- we've always talked about two criteria for success at the core. Inlet for fiber loading. One of them was seven-and-a-half grams per fuel assembly, which we adopted as a limit for boric acid precipitation. We've abandoned that. We no longer have that. We do a deterministic evaluation for hot leg switchover timing. That's all that amounts to with no criteria on the core.

It could be completely blocked for all -- we don't want it to be, but it could be completely blocked and we would still meet our boric acid precipitation hot leg switchover timing. But if we exceed 15 grams for fuel assembly, we'd no longer be able to cool the core. That's pretty much the information on this break. And hot leg breaks and small breaks in fact are treated differently. As I mentioned earlier, all we have in the risk-informed category are large breaks.

So moving to slide 52, just to summarize what we've talked about is shown on the previous slide, the fiber mass is conserved at three locations, the sump pool, the strainers and the core. The flow network that supports the mass conservation we'll see in the next slide, but it can be described as a set of time-dependent mass conservation equations.

The other kind of odd thing about all this is because of the filtration function associated with the measure data that we took with the strainer's ability to capture and retain debris, they turn out to be non-linear, a non-linear set.

And then the filtration function form is shown on slide 53. Bit of a busy slide. So the alpha train total flow goes through the strainer where we have this filtration function we mentioned.

MR. MURRAY: So we've got that slide.

MR. KEE: Yes, and you'll see that.

MR. MURRAY: That picture is blown up for a better look at --

MR. HARRISON: That will be the next slide.

MR. KEE: Correct. And where we have this filtration that goes on as the pool -- whatever the concentration is in the pool passes through according to the flow. Some is captured. Some is released. And that's what goes down stream. And then recall that some of it goes right back to the pool. That's that gamma that we initially mentioned. The gamma goes straight back to the pool. And then some goes on to the core, but remember that some -- we're looking at cold leg breaks. Some goes right back to the pool again because it flows out the breaks. So the only amount that's really demanded by the core is that required to meet decay heat load.

CHAIRMAN BANERJEE: Typically in most -- everybody does this. It's about 60 percent of the -- typically for cold leg breaks, his statement, is getting to the core. I may be wrong with that number, but it's close to that, right, for the cold leg break? Is the cold leg break limiting for the core, or is it the hot leg break?

MR. KEE: Well, I think we've talked about this previously, but we show that we can completely block the core and maintain cooling in hot leg breaks, and in fact small breaks, so with complete blockage of all the flow channels that either bypass or go straight through the fuel assemblies. We also showed some results for -- if you didn't happen to block up all the channels --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Just remind me, how was it that with the hot leg break you kept that name?

MR. KEE: Sure. So when we go to recirculation switchover -- so there's a period of time, 20 minutes or so in a large break when we're pulling water from the RWST. Then we switch over to recirculation, ECCS sump recirculation. At that point in time we say that we've blocked the core. We did this as a screening -- very early we've done this as a screening calculation. Totally blocked the core and the core bypass. So that's some kind of a theoretical worst case.

CHAIRMAN BANERJEE: Yes.

MR. KEE: And of course we're pumping in a lot of water and it has to go somewhere. And the only choice it has is to go back up through the steam generators, through these channels that we mentioned, those cooling channels to the upper head that we reviewed, that they were slightly larger than we'd modeled and so forth. That's the mechanism is that if it doesn't block the core, then it goes through the core. If it blocks the core, it goes around. The water has to go somewhere and those are the only choices it has. And so when it goes --

CHAIRMAN BANERJEE: You've done this calculation with --

(Simultaneous speaking)

MR. KEE: Yes. Yes, sir.

CHAIRMAN BANERJEE: And you have the results? Okay.

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: And you've submitted this with staff to look at?

MR. KEE: Yes, sir. Len Ward has been -- we actually worked closely with Len Ward and Ashley Guzzetta to clarify --

CHAIRMAN BANERJEE: They are going to look at this and see --

(Simultaneous speaking)

MR. KEE: Yes, I think that's an ongoing review.

CHAIRMAN BANERJEE: Okay.

MR. KEE: Or it may be finalized. I'm not sure where they are on that.

CHAIRMAN BANERJEE: But that's the way around the 15 grams of fiber?

MR. KEE: Oh, no. No, for cold leg break we don't get around that.

CHAIRMAN BANERJEE: No, no, cold leg -- but the 15 grams --

MR. KEE: For hot leg break.

CHAIRMAN BANERJEE: -- is for the hot leg break, right?

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: The cold leg break is a little bit higher, yes. If I remember --

(Simultaneous speaking)

MR. SMITH: Yes, this is Steve Smith. Cold leg break I think was okay with 18 grams.

CHAIRMAN BANERJEE: Yes, 18 grams.

MR. SMITH: So using 15 is okay. It sounds good to me. And I think that depending on the plant the percentage of fiber that gets into the core on a cold leg break widely varies depending on what your ECCS flow is. So since they have a high ECCS flow, they have relatively low fraction getting into the core.

MR. KEE: Yes, we'll show that.

CHAIRMAN BANERJEE: Yes, so the devil here is in the details on this, yes.

MR. KEE: Yes, sir. So as I mention here, we have these measured data that we took --

MEMBER SCHULTZ: Ernie, before you go on --

MR. KEE: I'm sorry.

MEMBER SCHULTZ: -- just for my clarification, could you back up a couple slides to 51? The title of the slide is "Fiber Penetration Uncertainty Analysis." Why is uncertainty analysis chosen as a descriptor?

MR. KEE: So it took me several slides to get to the point where I actually show that --

MEMBER SCHULTZ: Okay.

MR. KEE: -- but you'll notice --

MEMBER SCHULTZ: I looked ahead several slides, but I didn't see it yet. But --

MR. KEE: Oh, well, if --

MEMBER SCHULTZ: -- if you're going to come to it and it will be clear, then I'll wait.

MR. KEE: Yes, I'll show what I mean, but I just wanted to lay conceptually the ground work of where that comes from. So part of it is the hot leg break where we've taken a very extreme position. And then the cold leg break we've measured some things. And those data of course are uncertain. And so we look at bounds of that. And that's what's coming.

MEMBER SCHULTZ: That's sort of a title for the forthcoming four or five slides. I got you. I'll wait. Thank you.

MR. KEE: Yes, so first and foremost is that measured data, as we all know, have uncertainty.

MEMBER SCHULTZ: We're on slide 54?

MR. KEE: I'm sorry, we went to 54. And so now we're talking about putting fiber in on a strainer and actually measuring in small quantities how much gets through. We just keep adding it and adding it and adding it so that we know how much was collected and how much was passed through.

So we actually did these tests on a full-size module at Alden and made these measurements. And it can be shown or whatever that these data can be bounded by these lines that are bounding the low filtration efficiency and the high filtration efficiency. So when it reaches one, the filtration efficiency equals one, that means 100 percent filtration efficiency.

This looks like it gets to one. I don't believe it ever gets to one because we actually used -- the bounding function on these two bounds ends in an exponential. You can see it more clearly on the lower bound.

CHAIRMAN BANERJEE: Strainer mass means the amount on the strainer?

MR. KEE: The amount collected. And this is collected on a single module, so these results have to be scaled to the full plant. So as Wes already mentioned, there's 20 of these modules, so you have to be careful to realize that this is what got collected on one. And so there's 20, and so there's actually -- whatever gets through one, 20 times that much gets through.

CHAIRMAN BANERJEE: Well, what tends to happen of course is that you've blocked these sequentially. What happens is you block one and things are bypassing it through the others and it just goes on. So until you -- it doesn't happen like all of them blocked together.

MR. KEE: Yes, sir. So that kind of behavior has been observed on some strainer designs.

CHAIRMAN BANERJEE: Large strainers. Areas get blocked and --

MR. KEE: But these particular strainers that are installed, that we had installed at South Texas are designed particularly to avoid that type of loading. They're called uniform loading and they're designed specifically to ensure that they load up uniformly. So that's how come --

CHAIRMAN BANERJEE: You have evidence to that effect?

MR. KEE: Okay. I'm going to have to look at Wes, because that was done by --

MR. SCHULZ: PCI, right.

MR. KEE: -- PCI.

MR. SCHULZ: That's evidence from our tests we've done and that we've done -- other folks have done, too, yes. That's a feature of this advanced design strainer.

MR. KEE: They're literally designed to do that.

CHAIRMAN BANERJEE: So a test on one strainer can be carried over to multiple strainers, right?

MR. KEE: I think that's something we need to --

MR. SCHULZ: For uniform loading?

MR. KEE: Yes.

MR. SCHULZ: I mean, that's the feature of the PCI design, yes.

CHAIRMAN BANERJEE: Well, that's a claimed feature.

MR. KEE: Claimed or shown.

(Simultaneous speaking)

CHAIRMAN BANERJEE: Well, I think you should show that this is consistent also with the amount that they collected downstream in your experiments, right, because they did -- I understood from what Steve was saying that they did collect what was happening -- what went through downstream. They didn't separate it into fiber and particulate, but you have the total amounts.

MR. KEE: Okay. So just to clarify on this, this is only fiber that we're looking at --

CHAIRMAN BANERJEE: Right, right.

MR. KEE: -- passing through.

CHAIRMAN BANERJEE: But everything has to hang together. You've got experiments with real debris, I mean mixed debris, at least some representative experiments which you did July 2008 and in February 2008 and --

MR. KEE: But we didn't do bypass. I just --

(Simultaneous speaking)

CHAIRMAN BANERJEE: I thought Steve was saying they collected what was happening downstream.

MR. KEE: I don't --

(Simultaneous speaking)

MR. SCHULZ: We did collect bypass in 2008, yes.

MR. KEE: Like this?

MR. SCHULZ: We have data, some data, yes.

MR. KEE: Oh, I think it's pretty limited.

MR. SMITH: This is Steve Smith. The way the bypass was collected during those tests, they didn't -- during these tests they did full filtration to be sure they knew everything that came through the strainer because it's much easier and much more accurate quantification. For testing that they did in 2008 they took grab samples. So they were only getting grab samples to determine how much they were getting passed at each moment in time on --

(Simultaneous speaking)

CHAIRMAN BANERJEE: So you feel that fiber only in place of fiber plus particulates is conservative in terms of the pass-through?

MR. SMITH: I didn't understand.

CHAIRMAN BANERJEE: In other words, if you have particulates it's a better filter for fiber for the -- so the real situation this could be conservative.

MR. SMITH: It's probably a better filter with particulate.

CHAIRMAN BANERJEE: Yes. Well, it would be nice to see those grab samples, what they found. This was done where, in Alden, too?

MR. SMITH: Yes.

CHAIRMAN BANERJEE: With fiber only? With only single discs?

MR. KEE: Well, the module, a full module.

CHAIRMAN BANERJEE: Oh, a full module?

MR. SMITH: It was the same setup.

CHAIRMAN BANERJEE: Okay. Same setup. All right. No, I got confused.

MR. KEE: Wes showed that picture, so if we need to, we could go back.

CHAIRMAN BANERJEE: No, no. I know what it said.

MR. KEE: Okay.

CHAIRMAN BANERJEE: Fine.

MR. KEE: So, yes.

CHAIRMAN BANERJEE: With a full module?

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: And what this shows is that low loadings you get about 40 percent going through?

MR. KEE: Roughly.

CHAIRMAN BANERJEE: As it loads up, less and less goes through, yes.

MR. KEE: Just like your air-conditioning filter.

CHAIRMAN BANERJEE: Yes.

MR. KEE: That you always forget to change.

CHAIRMAN BANERJEE: This is the point I was making earlier, that when you have less fiber, more goes through.

MR. KEE: Correct. Absolutely. Yes, sir, that's physically -- meaning it makes sense. Right.

CHAIRMAN BANERJEE: Right.

MR. KEE: Fortunately or unfortunately we have plenty to stop it from going on.

CHAIRMAN BANERJEE: So we should add fiber to our plants, right, to get rid of the downstream effects?

MR. KEE: This is what the risk kind of perspective brings. They're competing effects, right?

So I want to just move to slide 55, if we're done with that. So we've reposed these equations in RoverD and we've solved them. The staff is familiar with an explicit method that has a lot of reliance on time dependence. We now have redone that work in implicit solver. That doesn't suffer from time step effects. And these are the differential equations that we solved. They're there for people to look at.

MEMBER BALLINGER: Oh, it's lsoda? I know lsodi and lsode. Never heard of lsoda.

MR. KEE: David, did I make a typo there?

MEMBER BALLINGER: The "i" is the implicit. The "e" is the explicit. It's just a sparse matrix solver, right?

MR. KEE: No, it's an ADAMS method implicity solver for -- yes.

CHAIRMAN BANERJEE: But you still have to solve, if it's implicit, a matrix --

MEMBER BALLINGER: It's basically a matrix inverted, yes. But it's a spare matrix inverted.

CHAIRMAN BANERJEE: Then why would you have to do that for an explicit method?

MEMBER BALLINGER: You can do it either way.

CHAIRMAN BANERJEE: Yes, but you wouldn't need to. Anyway, this is --

MR. KEE: Yes, it's just a point that we're not doing it explicitly any more.

CHAIRMAN BANERJEE: Some ode solver.

MEMBER BALLINGER: Those two routines we love to hate.

CHAIRMAN BANERJEE: I have no doubt that they were solved accurately.

MR. KEE: It was several decimal places. The mass balance is accurate. That's something we checked.

So this is what we get out of this solution to those equations. And this is the final point to answer the question about the --

(Simultaneous speaking)

CHAIRMAN BANERJEE: The uncertainty, was that that band you showed in the previous slide?

MR. KEE: There's more included here than that.

CHAIRMAN BANERJEE: Oh, okay.

MR. KEE: So I looked around the area where we passed with the deterministic method. We ran cases where we had a lot of debris with very little water volume. These actually can't happen this way, but to really bound it, if you assume that basically a more than large amount of debris is in the sump in the small water volume, that represents a high concentration. And then solve that at the upper band and lower band of the data, the measured data. And then do that the opposite, the upper and lower bands of the measured data. And these are the kind of results that we obtained with that kind of uncertainty or bounding analysis, if you will.

CHAIRMAN BANERJEE: I'm trying to understand. I understood the bounds of the data that you showed in the previous slide. And you do these calculations using those uncertainties, but you also propagate that into the concentration field, is that it?

MR. KEE: That we did not do here. We could do that, and we do that in CASA in fact, but again, there was some uncertainty as to how that was being done. So in this case we looked at explicit bounds. So we looked at the lower bound of the data, the upper bound of the data.

CHAIRMAN BANERJEE: Of the filtration data?

MR. KEE: The filtration data. And then we looked at low-concentration and high-concentrations in the pool. Like I think you were alluding to, well, what about a low concentration and a high concentration? Is that going to be a bad result?

CHAIRMAN BANERJEE: Right.

MR. KEE: And so what this shows is if you take all those kinds of questions and pose them --

CHAIRMAN BANERJEE: Okay. So you effectively answered the question I had.

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: Yes.

MR. KEE: That was what I was trying to --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Can you lead us through this very slowly, because I was confused by these --

MR. KEE: Do we need to go back?

CHAIRMAN BANERJEE: No, no. I understood what you did. So here, what do these --

(Simultaneous speaking)

MR. KEE: So these concentrations, they're funny units; I acknowledge that, but we just kind of looked at this in terms of native units.

CHAIRMAN BANERJEE: Yes.

MR. KEE: So we put a more than -- put in 500 pounds, the equivalent of roughly 500 pounds, I believe that was put in for debris and the small break pool volume. So we had a large amount, a very large break with a very small break pool volume, which was around 300,000 gallons.

Do you recall that number, Bruce? Anyway, it reduces to the -- the high one is 0.832 grams per gallon in terms of the C sub-p that we showed on the previous full concentration. So that's what's being pulled through the strainer in terms of the concentration initially. And that will attain whatever it will attain as time goes by in the mass conservation. And what that produces at the lower bound of the filtration function is 441 grams on the core. And what it produces on the upper band of the filtration function, the better filtration is 247 grams. This is what really drives everything.

Then looked at it with very little debris, less than the 192 pounds of fine fiber and with a very large volume in the pool, so very low concentration of fiber in the pool, high and low bands of the filtration function. And these are the time-dependent results from that set of differential equations that were shown.

CHAIRMAN BANERJEE: So what's the most sensitive there? How much bypasses the core?

MR. KEE: Well, the filtration efficiency is huge, right?

CHAIRMAN BANERJEE: Yes, that --

MR. KEE: And then the next probably

highest one is the concentration in the pool. You see there's maybe 10 percent. And I also looked at different flow rates, because we can do that, and that was really uninteresting. So instead of making this thing very complicated with different flow rates, those can be examined, but they don't produce any kind of significant change in the results. I mean, the point is we're looking at like two --

(Simultaneous speaking)

CHAIRMAN BANERJEE: You've got a number of parameters in your model, right?

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: One is gamma superscript a, gamma superscript b, gamma superscript c. And then you've got -- I assume lambda is another parameter?

MR. KEE: Yes, sir. Well, we don't actually need lambda. You'll see that the algebra gets rid of that.

CHAIRMAN BANERJEE: But you use gammas. They're what you call gamma superscript k. How do you select those?

MR. KEE: Okay. So the k refers to the train. So there's three trains. K is a, b, c.

CHAIRMAN BANERJEE: Right, a, b, c. Yes.

MR. KEE: And the gamma of course is the fraction of flow that is fraction of flow that goes to containment spray. And lambda is the fraction that goes to the core, but you don't need that. The algebra gets rid of that. And so all you need is to -- this second equation does the weighting. That flow network, as you recall, all the flows come together in the reactor coolant system that arrived there. And then they each have their individual concentration that needs to be appropriately applied to the flow --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Right, I think one of the most -- certainly one important would be gamma superscript b because that determines the split of the flow that goes to the core in the bypass, right?

MR. KEE: You would --

CHAIRMAN BANERJEE: How sensitive is it to --

MR. KEE: It's not sensitive, really.

CHAIRMAN BANERJEE: It's not sensitive to gamma b?

MR. KEE: No. But I mean that's totally -- we can run those cases. I ran several different scenario and --

CHAIRMAN BANERJEE: So typically what

people will do is they will simply assume some fraction is going to the core and some fraction bypasses?

MR. KEE: Oh.

CHAIRMAN BANERJEE: And then they'll say 60 percent of the fiber goes to the core because --

MR. LETELIER: If I could interject. This is Bruce Letelier from Alion. The choice of a gamma will change the time behavior of those figures --

CHAIRMAN BANERJEE: Yes.

MR. LETELIER: -- but it won't change the ultimate accumulation.

MR. KEE: Maybe that's the point is what I wrote here was like after many, 150 minutes, what it achieved after a long -- couple or three hours.

CHAIRMAN BANERJEE: Ultimately all the water gets filtered. Is that -- so it --

MR. KEE: At some long time, yes. Yes. Yes, sir. It builds up fairly rapidly so you see that it drops off the rate that it builds in.

CHAIRMAN BANERJEE: Yes.

MR. KEE: And with regard to the flow split, we treat that directly as --

CHAIRMAN BANERJEE: I can see that it --

MR. KEE: The Q --

CHAIRMAN BANERJEE: -- gives you the time constant.

MR. KEE: There you go. Q as a function of time is there, yes. Which is just a decay heat demand, which is well known.

CHAIRMAN BANERJEE: Okay. So I think that's great. Comes up with a very positive result. What we might want to do is, if you've finished with this, take a break now, because you're now going on to things which are more in the delta CDF and all these things.

Our distinguished Chairman, won't you after lunch take over a little bit?

(Laughter)

(Simultaneous speaking)

CHAIRMAN BANERJEE: Anyway, so I think it would be a good point to take a break for lunch. We all agree? Whether we fight with each other and decide who's going to be chairing it, that's an internal -- so what about a lunch break for an hour? Let's come back at 1;15.

(Whereupon, the above-entitled matter went off the record at 12:05 p.m. to reconvene at 1:15 p.m. this same day.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:16 p.m.)

CHAIRMAN BANERJEE: We are back in session and we will continue from where we were. Before we go to the next step, I just had a little question related to the previous thing, just a matter of clarification When we looked at this little diagram on page 53, or slide 53, you say the core acts as a fiber mass sink.

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: Do we have a filtration function for the core there?

MR. KEE: Hundred percent.

CHAIRMAN BANERJEE: Everything comes out there?

MR. KEE: Anything that goes to the bottom of the core is -- it's a little bit of a conservatism, but that's what we have assumed, yes.

CHAIRMAN BANERJEE: Okay. And then what

accumulates in the core is shown where?

MR. KEE: M sub-c is --

CHAIRMAN BANERJEE: Right, but you showed us in slide 56 --

MR. KEE: Yes, the --

CHAIRMAN BANERJEE: -- is that the amount that's going into the core over time?

MR. KEE: Yes, sir. The second equation, yes.

CHAIRMAN BANERJEE: This is a --

MR. KEE: Well, the amount that's accumulated of course is the rate of change of that.

CHAIRMAN BANERJEE: So the total core fiber mass, that assumes 100 percent coming out in the core, whatever goes to that core?

MR. KEE: A hundred percent of what -- that split in the cold leg break, yes, goes to the bottom of the core. Actually, this is pretty much what everybody does now even.

CHAIRMAN BANERJEE: So everything that goes to the core stays in the core?

MR. KEE: That's what we assume, yes, sir.

CHAIRMAN BANERJEE: Okay. So that basically is the cumulative amount which is captured in the core?

MR. KEE: Yes, sir. The final answer, these are -- if I had labeled this graph, it would have said mass of fiber on core, M sub-c.

CHAIRMAN BANERJEE: M sub-c?

MR. KEE: That means these graphs as a function of time, yes.

CHAIRMAN BANERJEE: Great.

MEMBER SHACK: Well, you have total core fiber, which is close.

MR. KEE: Is that what it says?

MEMBER SHACK: Yes, after you squint enough.

(Simultaneous speaking)

MR. KEE: It used to be bigger. Oh, yes, there it is. Total core. Yes.

CHAIRMAN BANERJEE: Yes, so just to clear things up, the strainer removes the rest of it effectively, right?

MR. KEE: Yes, sir. Yes, these are the only two places where filtration occurs. On the strainer is -- according to those data. And the core is 100 percent by assumption.

CHAIRMAN BANERJEE: So I'm just trying to picture this. Flow goes through the strainer. Initially 60 percent of that material is caught on the strainer right away, whatever the flow was. And then some fraction of that flow goes through the core.

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: And some fraction goes elsewhere. And the fraction that goes through the core has 40 percent of that liquid left, right, in there? I mean, 40 percent of the fiber left. Whatever goes through the core. And that's taken out right away.

MR. KEE: Roughly, but of course there's -- recall that some -- if you're referring to the figure on the left --

CHAIRMAN BANERJEE: Yes.

MR. KEE: -- that some returns directly. The gamma --

CHAIRMAN BANERJEE: Right, the --

MR. KEE: -- splits. So it's right back to the sump and then -- yes.

CHAIRMAN BANERJEE: Yes, and it goes through it again?

MR. KEE: Through it again.

CHAIRMAN BANERJEE: So I'm just trying to visualize what's happening. So 40 percent is passing through typically right at the beginning.

MR. KEE: Right away at the start, very start, the first --

CHAIRMAN BANERJEE: Yes.

MR. KEE: Yes.

CHAIRMAN BANERJEE: So, and that 40 percent is split into two parts, or whatever.

MR. KEE: Right.

CHAIRMAN BANERJEE: One part goes through the core, is captured, and the rest is outside the core?

MR. KEE: Correct.

CHAIRMAN BANERJEE: And it builds up that slowly?

MR. KEE: Yes, we haven't examined the time --

(Simultaneous speaking)

CHAIRMAN STETKAR: -- is a big fraction. Gamma is a large fraction.

MR. KEE: That's another point.

CHAIRMAN BANERJEE: What is gamma-a and gamma-b, to be clear?

MR. KEE: As I mentioned earlier, that gamma refers to the containment spray and it's -- real rough numbers, 3,500 gallons per minute. Then the high head is like 1,500-1,600. And then low heads, rough, 35, 38, some number like that. So it's, as I recall, like 40 percent total of the flow.

CHAIRMAN STETKAR: For a large LOCA, but as you get smaller, it's going to be a larger fraction, right?

MR. KEE: That's true. For a small LOCA it will be a larger fraction.

CHAIRMAN STETKAR: For a small LOCA it's a heck of a lot fraction.

MR. KEE: Yes, sir. Yes, because low head won't --

CHAIRMAN STETKAR: Low head won't be delivering flow.

MR. KEE: Shut-off head -- dang, I was trying to come up with that. It's roughly 400 PSI.

CHAIRMAN BANERJEE: Okay. So the picture you show here is -- for what case are you running, a double-ended cold leg break, or what is it?

MR. KEE: Well, in general any cold leg break.

CHAIRMAN BANERJEE: Any cold leg break does this?

MR. KEE: Yes, sir. Because the flow rates -- well, we can generalize it to any break size, but I looked at large breaks.

CHAIRMAN BANERJEE: So the case that you show here is for the --

MR. KEE: For a large break, yes.

CHAIRMAN STETKAR: This has got a large break?

MR. KEE: Medium-large. And that's what we're looking at.

CHAIRMAN STETKAR: Okay.

CHAIRMAN BANERJEE: And how much fiber? Is this 17 ZOI?

MR. KEE: No. Well, so nominally I'm looking around the 190 pounds, right, that we're concerned with. This is --

(Simultaneous speaking)

CHAIRMAN BANERJEE: This is for 190 pounds?

(Simultaneous speaking)

MR. KEE: -- much lower.

CHAIRMAN BANERJEE: Is this for the 190 pounds?

MR. KEE: So these --

CHAIRMAN BANERJEE: The picture that you're showing?

MR. KEE: Oh, sorry. So these fractions that are shown, the high and low, one's much lower than 192. One's much higher. And then the volume in the pool, as I mentioned earlier, doesn't -- it's kind of illogical because the pool volume -- to get a maximum concentration you would assume a small break. So pool volume with a larger break LOCA double the amount of fibers, what was --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Well, what did you use here --

MR. KEE: Double.

CHAIRMAN BANERJEE: -- 193 pounds of fiber?

MR. KEE: Oh, no, no, no, no. Which, the top? For the high --

CHAIRMAN BANERJEE: Yes.

MR. KEE: -- that fraction is like 300,000 gallons in the pool and roughly 500 pounds of fiber.

CHAIRMAN BANERJEE: For the high?

MR. KEE: High. So looking at a really high, I actually thought -- oh, it does. That one makes the most. And then for low I pick a very -- 500,000. All of it's in there. I think I did more than that, 550,000, and divide it by less than 192 pounds to get a very low estimate of the concentration in the pool. That's what matters in the --

CHAIRMAN BANERJEE: Okay. So it's --

MR. KEE: But we can look at this as much as we want.

CHAIRMAN BANERJEE: Yes.

MR. KEE: It's very --

CHAIRMAN BANERJEE: So I think the staff is setting up an independent confirmation --

MR. KEE: Oh, good. Yes.

CHAIRMAN BANERJEE: -- calculation, right? Is that right?

MR. WIDMAYER: Yes.

CHAIRMAN BANERJEE: Yes. So, it's interesting. I'm surprised that so little fiber is coming out in the core given so much fiber. I mean, the physics is not clear because you've got two screens. One is the strainer and the other is the core. And so, why is it distributing in this rather unexpected way?

MR. KEE: Yes. So, I don't know that we'll answer anything right here, but this Q-c is a function of time. The earliest that that -- the largest value that would be seen by these equations for that number which is based on decay heat requirements is on the large break LOCA, like 20 minutes, half an hour in. So by then of course decay heat is very low. As a fraction of the total amount of flow, it's small. Like I mentioned, an enormous amount of flow goes through these emergency core cooling and containment spray systems. So a lot of it's going around the strainer, getting collected on the strainer and some of it's going down through the core, sure, and getting caught there. I think I'm just --

(Simultaneous speaking)

CHAIRMAN BANERJEE: So there's circulation around the strainer which is not going to the core?

MR. KEE: Correct. Yes. So, a lot is spilling out the break because it's not being demanded by the core boil off. A lot is being recirculated by the containment spray part. We can vary all those. And like I mentioned, we did look at sensitivities on flows, but without doing a huge matrix it became obvious that what the driver was the filtration function primarily in the concentration in the pool. But we made a solver that's completely general so --

CHAIRMAN BANERJEE: Yes, so the innovation here basically compared to other studies is that filtration function is made a function of the loading on the filter. Otherwise, you can just assume 40 percent goes through --

MR. KEE: Ah.

CHAIRMAN BANERJEE: -- or something.

MR. KEE: Yes.

CHAIRMAN BANERJEE: So that's the --

MR. KEE: And that would just be a --

CHAIRMAN BANERJEE: That's the innovation, yes.

MR. KEE: -- pure exponential kind of decay. Yes.

CHAIRMAN BANERJEE: Okay.

MEMBER SCHULTZ: This is with a full complement of the filtration system? I mean, all the strainers are in play?

MR. KEE: Yes, sir. So we're trying to look at downstream.

MEMBER SCHULTZ: Yes.

MR. KEE: So mostly coming from all of them in operation.

CHAIRMAN BANERJEE: Okay. So, I've think we've clarified things, so you can now continue with your delta CDF.

MR. KEE: So, this is slide --

(Simultaneous speaking)

MR. MURRAY: So, let me recap one thing, because I wanted to make sure it was clear. We had talked about we can look at both, we do look both on that and gate. When we ran through it, all of the -- and I think Ernie just hit it, was that what we found, those that went to failure was dominated by the filtration.

So the in-vessel effects we didn't have a failure or one that went to failure on the in-vessel effects. That correct?

CHAIRMAN BANERJEE: Well, we haven't talked about the hot leg, but you're saying there's some calculations that you've done which suggest that the hot leg break is not limiting, right?

MR. VAGHETTO: Excuse me, Mr. Chairman, is the phone line open? We have some people who aren't able to join.

MR. WIDMAYER: Let's open it. I can do that if you --

CHAIRMAN BANERJEE: Yes, let's do that.

PARTICIPANT: Well, you're talking about just to listen in, correct?

CHAIRMAN BANERJEE: Oh, the --

(Simultaneous speaking)

CHAIRMAN STETKAR: To listen in, it should be open now.

PARTICIPANT: Listen in? Okay. I thought you wanted them to talk.

CHAIRMAN STETKAR: Derek, don't open it.

MR. WIDMAYER: Okay.

CHAIRMAN BANERJEE: No, but let's verify. Can you check that they can hear? Can they send you an email that they can hear?

PARTICIPANT: Oh, we muted. They can't hear.

MEMBER REMPE: Yesterday that happened with Mike's line several times, that he couldn't hear.

MR. MURRAY: So, your question was before we went to the phone?

CHAIRMAN BANERJEE: The hot leg is never limiting. That's what you're saying?

MR. MURRAY: From in-vessel?

CHAIRMAN BANERJEE: Yes.

MR. MURRAY: That's what the results are.

CHAIRMAN BANERJEE: Because you've got things coming back in your RELAP calculations?

MR. MURRAY: That's correct. Ernie, the question is on the hot break why did hot leg break not carry us to core damage? And it's again what we already discussed.

MR. KEE: Yes. So if we can just look at this figure, in the hot leg break of course nothing's going out really from the cold leg side. All of the flow is going through. There's no split of this lambda. It's all going up through.

CHAIRMAN BANERJEE: Yes.

MR. KEE: And so, once again we assume it all blocks up on the core. And then we look at the thermal hydraulics for that situation at the time of recirculation switchover and verify that as I mentioned that the overwhelming amount of emergency core cooling flow will go up and over instead of --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Well, you calculated with RELAP, right?

MR. KEE: We calculate, yes.

CHAIRMAN BANERJEE: I mean you take the whole circuit --

MR. KEE: Yes.

CHAIRMAN BANERJEE: -- when you do the calculation with the hot leg break? It's a proper calculation --

MR. KEE: Yes, sir.

CHAIRMAN BANERJEE: -- with the resistance in the core that builds up as you get material in there?

MR. KEE: Okay. So just to describe that, summarize it, we assume a theoretical limit to -- so we assume that it's blocked when we go to recirculation. It's as if all the material that comes to the core blocks it all.

CHAIRMAN BANERJEE: But I guess most of the analysis that we've seen in the past, what they do is they put a K factor in the core. It can be varied.

MR. KEE: That would be nice, yes.

CHAIRMAN BANERJEE: And --

MR. KEE: More flow can go through then.

CHAIRMAN BANERJEE: -- you can get some flow through it.

MR. KEE: Yes.

CHAIRMAN BANERJEE: But what they're looking for typically is to keep the flow above an amount which leads to extended dry-out above the core. So there's a limit to which --

(Phone dialing)

CHAIRMAN BANERJEE: -- tell me what it is. But there's a temperature limit which is set --

(Bridge line interference)

MEMBER SCHULTZ: Ernie, just to confirm, on slide 56 the values that are shown there demonstrating that the maximum will not be reached, those correspond to 192 pounds.

MR. KEE: These actually are limiting cases for much more and more less for --

MEMBER SCHULTZ: Much more and much less? Okay.

MR. KEE: Basically in terms of the concentration, let me put it that way.

MEMBER SCHULTZ: Okay.

MR. KEE: Yes. So what matters to this is what's the concentration in the pool, right?

MEMBER SCHULTZ: Understood.

MR. KEE: What we start with.

CHAIRMAN BANERJEE: So you started with either much higher than 192 pounds in the pool or much lower. Okay. And this is how it looks, what ends up in the core.

The calculation for the hot leg I was talking about typically would look at what goes into the core and loss related to that. So it's not necessary to completely block the core. It's only necessary to block it enough to get extended dry-out so that if you get say quality of -- let's take a number. I don't want to tell you what tell you what other people are doing, but if they have 50 percent quality, that can exit quality, that could lead to regions of dry-out which is sufficient to give problems.

So there is flow still. So it's just a pressure loss criteria that you set, the K factor. There's some flow. It's not completely blocked off. And that in some way got translated back to a criterion, if you wish, of 15 grams per channel. But if you're doing a more elaborate calculation, all sorts of flow paths and all, then you might want to do this properly with a K factor in the core due to blockage. If you completely block the core off, then of course you're going to get everything drying out on top, right?

MR. KEE: Well, it's kind of a limiting case that's --

CHAIRMAN BANERJEE: Yes, it's very much a limiting case.

MR. KEE: -- extreme. But the truth is I'm not familiar, but we don't -- Rodolfo, do you recall the worst case void fractions for the large double-ended hot leg complete blockage?

MR. VAGHETTO: This Rodolfo from Texas A&M. You are asking like the void fraction after the full core blockage at the bottom of the core?

MR. KEE: Right.

CHAIRMAN BANERJEE: No, no, no. All I'm asking is if you block the core completely, then you're going to dry out everything above the blockage anyway, which is a worst case scenario?

MR. KEE: Actually that --

(Simultaneous speaking)

CHAIRMAN BANERJEE: -- take that?

MR. KEE: We do analyze that case, exactly that case at the time of recirculation switchover and we don't get dry-out, I don't thin.

MR. VAGHETTO: No, what we have observed too during the simulations is that at the time you block the core, of course you see a peak cladding temperature increasing. But because we three injecting trains available in the cold leg side, what happens, the water start like -- the pumps start filling the vessel from the cold side and the first injection of water happens very quickly through the flow path to the vessel entrance with the upper plenum. So sadly you have water arriving to the core at the top of the core from what we have mentioned the last time being what we call the upper plenum spray. And after there is an additional --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Upper plenum what?

MR. VAGHETTO: Last time we mentioned these holds all the way around. We call it the upper plenum sprays.

CHAIRMAN BANERJEE: Okay.

MR. VAGHETTO: And the core basically sees the most immediate like flow from the cold side. And then after, depending again on the break size, you may also get the steam generator and have an additional flow from the steam generator spill. So you do see an increase in the peak cladding temperature, but then at some point when you start to like filling the -- replacing the evaporation rate, then that peak cladding temperature stabilizes, and it stabilizes at a level below the 800 Fahrenheit we used as a figure --

(Simultaneous speaking)

MR. KEE: And do you recall, do we achieve 50 percent void fraction in that case as it lowered? I thought it was --

CHAIRMAN BANERJEE: No, quality. The question is what is the quality?

MR. KEE: Quality?

CHAIRMAN BANERJEE: Yes.

MR. KEE: Wow.

MR. VAGHETTO: Honestly I don't recall after the core blockage, but I mean based on what I see in the peak cladding temperature, you have to -- I mean, the peak cladding temperature stabilizes, so you have to have a --

MR. KEE: And we're looking for like 800 degrees as an acceptance for these cases on the peak clad.

CHAIRMAN BANERJEE: That's correct. Yes. Okay. So I think you're going to discuss this at a later point, all these RELAP calculations and things, right?

MR. KEE: We didn't plan on getting into that in detail, because last session we --

CHAIRMAN BANERJEE: You went through it. I remember those holes and the things, yes.

MR. KEE: Yes. So those results that we were relying on then we rely on today, continue to.

CHAIRMAN BANERJEE: Okay.

MR. KEE: And as we mentioned, the staff has all those input decks. Everything that we used in the November submittal we've provided to Len Ward and Ashley Guzzetta.

MR. MURRAY: Mr. Chairman, were you talking about talking about it more today or in the future? What was your thoughts?

CHAIRMAN BANERJEE: Not today.

MR. MURRAY: Okay.

CHAIRMAN BANERJEE: Yes.

MR. MURRAY: That's what I wanted to make clear.

MR. KEE: Oh, okay.

MR. MURRAY: Okay. I wanted to make sure Ernie was clear on that.

CHAIRMAN BANERJEE: Yes.

MR. MURRAY: So, okay.

CHAIRMAN BANERJEE: Eventually we'll get the staff's calculations as well as yours.

MR. MURRAY: Sure. Okay.

CHAIRMAN BANERJEE: So I think we can go back to delta CDF now.

MR. MURRAY: I think we're ready. I think this is slide 57.

MR. KEE: So we move to slide No. 57. So this is kind of a recap that -- first of all, the RoverD screening stage. At each weld location with a break producing more fine fiber in the sump than what was tested, we record the smallest break size at that location. And then we realized that some -- and as we've talked, these 530-some-odd locations don't even create that much fiber at double-ended guillotine size break.

We use NUREG-1829 as a basis to determine frequencies for these breaks that we assign to changing core damage. We basically observe two principles kind of that we wanted to follow in doing so, and they're written here. In the limiting case for which ever weld and every break above the smallest diameter; call it X, or whatever, is considered bad; that is at that break size more comes to the sump than what were tested, more fines, the break frequency should be just exactly

NUREG-1829. The exceedance frequency is X. So we're looking at exceedance frequencies at these breaks sizes, which are the smallest at each location that exceeds the amount that was tested.

And the second kind of guiding principle is RoverD should depend on the number of welds in the RoverD risk-informed category. So the number of locations now we're talking about in the risk-informed category. And in particular the frequency should increase if new welds are added to the set that we had before, bad welds. And this in fact you can see happens with the single-train case.

Then the way we do this and what we refer to this as is what we call top-down adherence to NUREG-1829 published frequencies. So notionally we're coming up with an initiating event frequency that we basically assign to delta CDF.

There are some equations here. We wrote kind of in a very general form on the slide that was the risk part of the RoverD. So we had some weighting times, these frequencies, right? So now we're adhering to these principles that we wrote down where for at any particular category we call this now of breaks we look at -- examine all the locations where a size that occurred could -- wherever the location is that that size failure could occur or larger, we count up all of them. So that's the total number of opportunities in that range of break possibilities.

We divide that into all the -- each one, one by one, the smallest break size at each location where the weld -- where the fiber fines were exceeded. So the category of D-i-small is a pipe category. So this is written here. If category 1 is one-inch pipes, category 2 is two-inch pipes, then for a break of 1.75 inches, the category is 2, because the opportunities are in the two-inch size. So in this way we go look at each category the same way competitively, and some, all those frequencies then will get some frequency that is -- will -- in the limit, any kind of a limit will match the exceedance frequency for NUREG-1829, realizing we have to interpolate. And that's for kind of one set of scenarios. So let's conceptually think this applies to the two or more train cases.

So if we have two states now, we're going to wind up -- and I guess at this point I should mention how we look at the single-train case. I think I mentioned earlier that of course -- and somebody brought this up, well, if there's just one train running, there's going to be a lot more fiber collected given even concentration in the pool. And that's true. It's probably conservative to assume the same amount because the velocities would be a lot lower, but let's for the moment presume that that's how that goes. So with two trains you have X amount of debris that gets on the strainers for the threshold, which was 191.78. And for one train in operation, well, you better only allow half that much to accumulate because all the fiber is on one strainer now, not spread over -- the same amount of fiber is on one strainer instead of being spread over two.

So what does that do? That means for the single-train case the break sizes that correspond to that case are much smaller, or they're still large, but they're smaller than for the two-train or three-train case.

CHAIRMAN STETKAR: Okay. So you actually do adjust the break sizes for the single-train case versus the two or more?

MR. KEE: Yes, sir. Exactly. So then all the other assumptions that go with the two-train test and so forth, they more or less apply if you accept that scaling. So it goes in the right direction. It kind of behaves the way you want it to.

And so, the only thing that remains is how do we deduce what fraction of the single-train should -- what fraction of the cases should have the single-train frequency? What fraction should have two or more? And so, we just divide the success frequencies out, and that's the weight.

CHAIRMAN STETKAR: About 75 percent should have the single-train success, and about -- 75 percent of the breaks regardless of the size you should win if you have a single train. Any break in loop D you can win with a single train, so that's 25 percent there, and two-thirds of the breaks on loops A, B and C. It's simple math. Seventy-five percent of the time you win with a single train.

MR. KEE: Well, yes, assuming conditionally that that's where it will let you have, right? But the frequency with which you realize a single train is very small. It's on order of four to the minus eight per year, whereas the two or more train case, that's -- I don't recall the frequency exactly. Ten to the minus -- but it's like 97-98 percent of the cases are the two or more trains in operation. That's the most likely case.

MEMBER BLEY: But you still account for them?

MR. KEE: Sure, by the frequency that you realize two or more trains and the frequency you realize one train. And we already kind of mentioned that we over-count that success because we're looking at the frequency that we come through to recirculation --

(Simultaneous speaking)

CHAIRMAN STETKAR: But this frequency, Ernie, are you just looking at a fault tree model that says what fraction of this fault tree -- that says X and what fraction of X has two trains running, three trains running and one training, or are you actually looking at the plant model for breaks and dividing the breaks among loops and dividing the injection flows among loops and seeing what fraction of all of the successes is one and only one train running versus two or three trains running? You say words like you divide all the --

(Simultaneous speaking)

MR. KEE: Almost --

CHAIRMAN STETKAR: -- but I can divide it several ways.

MR. KEE: Yes, sure. So almost what you said the first time is what we're doing, but of course we're looking at an event tree and we look at the success states that we get. When we come to recirculation with a single train, how often does that happen? That happens like very infrequently. How often do we come through recirculation with two or more trains? That happens almost all the time. And that's the DVI we're doing here.

CHAIRMAN STETKAR: Okay. I'll have to think about that.

MR. KEE: So we've already published in our November submittal these frequencies, so I mean they're -- you can just look them up. And you can see that the single train frequency is very low. It'll be a small fraction of the -- a very small fraction of the time do we see a single train go to LOCA with a single train in operation. Am I saying that right, David?

CHAIRMAN STETKAR: Well, okay. I'm still thinking. I can think and listen at the same time.

PARTICIPANT: All right. Okay. So let's move to slide 60.

MR. KEE: Oh. So, yes, so that last equation just sums up those DVI'd frequencies.

And then we ran several cases. And so this is what we refer to as delta CDF uncertainty. And some of these questions have arisen in the course of time, so there's some history behind why would you look at continuum break? Why would you look at double-ended guillotine break? Why do you look at the 5th, 95th? And so, just on the right-hand side of this figure --

PARTICIPANT: Use your mouse.

MR. KEE: Oh, yes. Mr. Mouse is my friend.

And we've talked about arithmetic and geometric aggregation in the NUREG-1829 elicitation. All these kinds of permutations that you can imagine and extremes of the elicited values are reduced in this table. And the important number I guess to focus on is the geometric mean, and a phi-hat is what I refer as the -- with a single train included case. So it's slightly larger than case two or case one.

And so, that's as you can see, in Region III, if we review the double-ended guillotine only approach. So we assume all these breaks. We don't look at the smallest. We say they all go to failure. Then we have a lower number, and that's kind of a result of the fact that all those frequencies associated with the double-ended guillotine break are larger. So there's all the results we have for all those different possibilities.

CHAIRMAN BANERJEE: They're reflecting, so you should carry on.

MR. KEE: Yes. So on slide 61, remember that we have to look at delta LERF. And one of the kind of endearing design features of the South Texas Project containment; and I think this is shared by most PWR designs, is that the reactor containment fan coolers, we call them, are independent of any of the concerns related to GSI-191. By that, I mean they don't clog up as a result of debris. They don't have any issues with debris. The cooling water to those is independently supplied from complement cooling water, if that happens to be the same supply, to what we call the RHR heat exchangers. That's what low head is pumping through.

So even though you lose those heat exchangers, you don't lose the reactor containment fan cooler heat exchangers. And that will keep containment pressure and temperature well below any design limits. Of course you're relying on your last barrier of defense at this point, but the change in LERF is simply -- all it is is strictly proportional to the change in core damage frequency at that point.

Then we examined those. We didn't do a lot of work there, but looked at the arithmetic, geometric means. And I just put the results for including the single-train case here.

MR. HARRISON: On slide 62.

MR. KEE: On slide 62. I'm sorry. And I think we've already talked about arithmetic mean aggregation produces like almost -- well, in this case more than order of magnitude higher estimates for frequencies. They're still borderline above the

Region III/Region II boundary, right, which is 1E to the minus 7. So this is 1.3E to the minus seven for kind of a worst case.

CHAIRMAN BANERJEE: Do you guys have some questions?

MEMBER BLEY: We're just looking at the one that Ernie didn't mention is it's often closed.

(Laughter)

MR. KEE: Is what?

CHAIRMAN STETKAR: Ninety-nine point nine percent of the way to -- nine point nine nine times ten to the minus eight. That's a --

MR. KEE: And every significant digit's --

CHAIRMAN STETKAR: That's a very, very precise estimate of --

MR. KEE: Absolutely.

CHAIRMAN STETKAR: -- a very uncertain value.

MR. KEE: Absolutely. So something we didn't do here, and we can do, we can go back and do this, or usually, is include the distributions that we've been using, the so called Johnson -- now the Johnson distributions to estimate uncertainties in a continuous fashion. But we just chose to look at these elicited quantiles.

CHAIRMAN STETKAR: Ernie, it's time for me ask you the same question again. You earlier said you're sticking to the linear interpolation because your assertion is that a different interpolation will always give you lower frequencies. I mean, to me that's not clear.

MR. KEE: It's not intuitively obvious. So the --

CHAIRMAN STETKAR: Especially because I've done other interpolations and they seam to give high depending on where you are in the break range.

MR. KEE: Yes, let's get into that. So where are we in the break range? We're at the very high -- the last two categories.

CHAIRMAN STETKAR: Yes.

MR. KEE: Which fall off roughly by an order of magnitude between the --

(Simultaneous speaking)

CHAIRMAN STETKAR: And that's true also for the single-train stuff?

MR. KEE: Yes, sir.

CHAIRMAN STETKAR: I mean, you're still up in the -- I don't know if you remember --

MR. KEE: I believe the smallest -- this is published in our RAI response, but I believe it was nine inches and change.

CHAIRMAN STETKAR: Even for the single-train?

MR. KEE: Correct, yes. Yes, sir.

CHAIRMAN STETKAR: Okay. That makes a big -- okay.

MR. KEE: Does that clear it up, the question then right there?

CHAIRMAN STETKAR: Yes.

MR. KEE: Okay.

CHAIRMAN STETKAR: Because you're only looking now at 9 up to what, 13 or 14, in practice?

MR. KEE: They're larger than that. Some of them go up to the full --

CHAIRMAN STETKAR: So you actually will get some --

MR. KEE: I think 13 inches is the smallest.

CHAIRMAN STETKAR: Yes, so you're going to trip over one of those inflection points. Okay.

MR. KEE: Yes, between --

CHAIRMAN STETKAR: Yes, I mean as long as you're --

MR. KEE: -- 7 to 14 -- there's an elicited 7-inch, an elicited 14-inch --

CHAIRMAN STETKAR: Right.

MR. KEE: -- a 14-inch and a 31-inch.

CHAIRMAN STETKAR: Right.

MR. KEE: Those are all the large and they're all going down by decade each.

CHAIRMAN STETKAR: Right, but my concern is I just look at the inflection points and that linear --

MR. KEE: Oh.

CHAIRMAN STETKAR: And you're only really spanning over one of those points, which reduces the sensitivity to what I was concerned about. So, okay.

MR. KEE: Yes, sir. I think it is almost guaranteed to overestimate. Not a lot, because they're -- as long as they're behaving --

(Simultaneous speaking)

CHAIRMAN STETKAR: I wouldn't play that card too strong, but --

MR. KEE: Oh, well. At any quantile maybe. Yes, I agree. Not necessarily for -- there's at least one point in that doesn't, yes, play right. But that's in small, small breaks.

So I just flipped to slide 63. And I think we talk about this, mentioned it earlier. We've gone over ad nauseam the cooling effectiveness for fiber blockage in cold leg breaks and hot leg breaks needs to be assessed. And we did that in two ways. Cold leg breaks we looked at the 15 grams for fuel assembly requirement.

And for the hot leg breaks, as we talked about, we did a limiting thermal hydraulics analysis. And we used to have a limit of seven-and-a-half grams. That was for boron precipitation. So we decided to eliminate any notion of the possibility that we have lower plenum mixing and so on and so forth. We're using a deterministic calculation to arrive at the hot leg switchover time to meet that requirement. So the analysis isn't dependent on lower plenum mixing.

And then we've already mentioned that -- and we've talked about this previously in this forum, that thermal hydraulic analyses for adequate cooling for all hot leg breaks and small cold leg breaks when their bounding blockage scenarios are met. And that's 800 degrees. So we're only talking about medium-large cold leg breaks that need to be examined closely for these fiber issues. And we've shown sensitivity analyses on how much of the fiber that was assumed in the strainer test around those values down lower is less than 15 grams for fuel assembly. So that's not a concern.

So just to wrap up on slide 64, what we've talked through, there are 45 locations which we discretize as spaces/welds. And the risk that arrived in the risk-informed category when we did the screening, the RoverD screening, with the exception of one all of those, are on RCS loop piping. We have one weld location on the pressurizer surge line. That's the smallest break that we have, which is roughly a 13-inch break and it's a double-ended guillotine break. That corresponds to maximum frequency as well.

MR. MURRAY: Yes, it would be a good opportunity to talk about those particular welds as far as like the one we just mentioned that's got weld overlay on it as well. So it's been mitigated.

MR. KEE: Maybe we should talk about -- so some are transitioned welds. And actually you're right, the safe ends on the pressurizer have been mitigated with weld overlays. And this one just happens to be a -- it's not a transition location, but that's correct, we've done that. We've also replaced all the steam generator -- the other, with the exception of the reactor vessel nozzle welds, have been replaced with Alloy 690. So when we replaced the steam generator, we mitigated those. So the ones that remain are the reactor vessel nozzle welds that have not been mitigated, but at double-ended guillotine break they don't exceed the 192 or 94 pounds criteria.

MR. HARRISON: And that's because their location and the type of insulation that's adjacent.

MR. KEE: So that's bullet No. 4. All welds that exceed the tested amount of fiber have either been mitigated or replaced.

Then all results using quantiles from NUREG-1829 geometric mean aggregation, both the RoverD continuum break model or double-ended guillotine break-only model -- so that's 5th to the 95th all the way across that spectrum. None of those exceed Region III. That's pretty stunning, actually. And that applies to delta LERF as well. The only quantiles that -- well, I called -- that's bad terminology here. The mean and the 95th exceed 1E to the minus 6 and put us in Region II, just barely, if we adopt the arithmetic mean aggregation, which we don't.

CHAIRMAN BANERJEE: So above what size roughly do you have to go to produce more than the 193 pounds?

MR. KEE: What size is the smallest one or --

CHAIRMAN BANERJEE: Yes.

MR. KEE: Thirteen inches break. Twelve

point one two.

CHAIRMAN BANERJEE: That gives you more than --

MR. KEE: All those are significant, too.

CHAIRMAN BANERJEE: That's above the smallest size?

MR. KEE: That is the --

CHAIRMAN STETKAR: That's for two-train.

MR. KEE: Well, that's the smallest size in the two or three-train case. Then I believe it's the same location, but it's only nine inches. No. Yes, I believe that's nine --

CHAIRMAN STETKAR: So single-train is somewhere in the 9 to 10-inch --

MR. KEE: Yes, 9 to 10. Yes. I can't remember the exact number. We have that. We've written that down. So these are pretty large breaks that we're talking about here, which is why the numbers are so low.

CHAIRMAN BANERJEE: So this is a large break LOCA-limited timed, right?

MR. KEE: Large break, yes, sir.

CHAIRMAN BANERJEE: So that's --

MR. MURRAY: Are we ready to transition?

CHAIRMAN BANERJEE: Sorry?

MR. MURRAY: Are we ready to transition into the next area?

CHAIRMAN BANERJEE: My colleagues here are the bosses here.

MEMBER SCHULTZ: Before you do, Mike, you had mentioned -- and I was behind you -- you had mentioned that on item 4, the mitigations associated with all welds -- what has been done there? Could you repeat that?

MR. KEE: So, at the steam generator safe transition weld, safe ends, you might say, those all have been replaced with Alloy 690 that's not susceptible to primary water stress erosion cracking. Now, on the pressurizer safe ends those have been treated with what they call the weld overlay that makes the pipe -- the wall thickness much thicker. And I believe; Wes will know this -- no, he doesn't know? I believe they also apply a compressive stress, so it's like torqueing a pole to -- before you can get any strain, you have to overcome the contraction.

MR. MURRAY: I believe it's also an Alloy 690 overlay.

MEMBER SCHULTZ: Right, and so --

MR. KEE: Oh, yes.

MEMBER SCHULTZ: -- this is a statement of what has been done, not as a result of this program we've gone and done all of these things?

MR. KEE: No, you might say it's serendipity, but --

MEMBER SCHULTZ: Yes, a condition based upon programs.

MR. KEE: But I think it bears on the fact that whenever the opportunity presents itself you do take care of these kinds of things.

MEMBER SCHULTZ: They have been taken care of for other reasons?

MR. MURRAY: That's right, for other reasons. We don't credit those in our break frequencies, is that correct?

MR. KEE: It's for LOCA.

MR. MURRAY: Right.

MR. KEE: That's what this is all about.

MR. MURRAY: Right, but we did those --

MR. KEE: That we've mitigated those to prevent --

MR. MURRAY: -- for LOCA purposes. Right. Did we answer your question?

MEMBER SCHULTZ: Yes. Thank you.

CHAIRMAN BANERJEE: Any other questions on this part? Corradini, are you there?

(No response)

CHAIRMAN STETKAR: He can't talk.

MR. WIDMAYER: Well, he's supposed to have a private line. Mike, can you say something?

(No response)

CHAIRMAN STETKAR: Perhaps he is saying something but perhaps the private line is also muted coming in.

CHAIRMAN BANERJEE: All right. So I think we'll leave Corradini to --

MEMBER SHACK: Can you go back to slide 58 again?

MR. KEE: Wow, that's way back there.

MEMBER SHACK: That's way back. Explain to me this argument again about the categories and the sizes. Are you -- sort everything into a DEBG in this slide? Is that why the category 1.75 equals 2?

MR. KEE: It's kind of notional. So these categories are defined by the extent of the pipe IDs. So starting with the smallest pipe, that would be -- so from -- it's zeroed. It's --

MEMBER SHACK: Well, no, let me just take a big pipe. I could have a break anywhere from one inch to a full DEGB. When you talk about break size, as a D-small-i, are you looking at a diameter or are you looking at true break size?

MR. KEE: Those Ds need to be thought of as the Ds -- and I'll say they're exactly -- they're not the multiplied by the square root of two. For DEGBs we're using the exact pipe ID. But below that pipe ID they are the -- exactly the numbers that you look at on the ordinate, abcissa, the x-axis of the NUREG-1829 frequency. Well, if that was plotted that way. If you think of it like that.

CHAIRMAN STETKAR: So a 14-inch diameter pipe, the two-inch D sub-i includes a 2-inch equivalent diameter break in that 14-inch pipe?

MR. KEE: Exactly. Yes, sir.

CHAIRMAN STETKAR: Is that what you're asking, Bill?

MEMBER SHACK: Yes, but I guess that's saying that the frequencies of the two-inch break is sort of independent of the diameter?

MR. KEE: It's strictly dependent on it.

MEMBER SHACK: I mean, I could have a two-inch pipe break and I could have a two-inch pipe break in a 14-inch pipe. Do those both have the same frequency in this -- the way this is done?

MR. KEE: Yes, they do.

MEMBER SHACK: Okay. Now that's not the

assumption that really underlies 1829. I mean the experts there, if -- when you did the -- back in the Appendix L table they did the elicitation by component. And then they had one-inch breaks, two-inch breaks in various size pipes. And those were not the same as the agglomerated ones that you did overall, right?

MEMBER SCHULTZ: They created a matrix.

MEMBER SHACK: And I'm not quite sure why -- and again, when -- I mean, the Fleming and Lydell report tried to deal with that. It seems to me you're getting rid of all of that now, but I'm not sure how you're scaling the overall 1829 results now to each break.

MR. KEE: So if we adopted -- and that's what we have in the past, adopted that hybrid approach is what we call it, and we in that approach we still match the NUREG-1829 frequencies. But here's what we do.

MEMBER SHACK: Yes, that's because you sort of smeared them out to match that. And that I understand. I mean, that one -- it's this one I'm having a harder time understanding, because that one at least preserves the notion that a 2-inch break in a 2-inch pipe has a different frequency than a 2-inch break in a 14-inch pipe.

MR. KEE: Not what we did. Not what we

did.

MEMBER SHACK: I think the weighting factor does that for you.

MR. KEE: It was based on the weld category, and that's the weld type. What really drove those results was the weld --

MEMBER SHACK: Well, but that also was associated with pipe size. I mean, there were categories --

MR. KEE: Okay. But these are all large pipes, so we're talking about the same kind of mix here.

MEMBER SHACK: Yes. Now maybe that's true if I only think that I'm really looking at one category of pipe on one end.

MR. KEE: But here's something --

MEMBER SHACK: And that doesn't bother me so much.

MR. KEE: And one other point to consider, if we did adopt that hybrid method where we DVI'd -- one more DVI is on the type of weld, then what would happen is those eight welds on the reactor vessel would come into play as much higher frequency locations. Then when we do the DVI, it would reduce the frequency on the mitigated welds. Now that's appropriate, but it's -- it wouldn't be huge, but it would -- that's the total effect that that would have. All the other welds would be treated identically the same. They would have -- they would just be -- the frequency would be reduced, those 600 --

MEMBER SHACK: Well, I mean, I'm trying to stay in 1829 world. Now in Fleming and Lydell they do try to take credit for their failure rate, which they change because of the mitigated weld. What I'm concerned about at the moment is just the 1829 notion that the different break sizes in different diameter pipes have different frequencies and preserving that versus what I think you've done here is preserve the overall break frequency for a size. But that's somehow independent completely of the pipe, which means that you're not getting the same frequency if you were associating that break with a location where it's generating debris. And you're going to get different answers from the two of them.

MR. FONG: Yes, this is C.J. Fong with NRR Division of Risk Assessment. We had a very similar question. When we read 1829, we saw the comment that all things being equal a break of a given size is more likely to come from a complete break of that pipe versus a partial break of a larger pipe. So we asked the question, too.

MEMBER SHACK; Well, it's more than just a comment on that. The nine experts that gave the component-by-component breakdowns gave the frequencies they thought we would get for category 1, 2, 3, 4, 5, 6 in the different pipe diameters. So I mean, there's data -- no, data is the wrong word. There are elicitation results that describe that.

MR. FONG: Right, and we asked in an RAI about that, and that's -- part of the response we got to the round 1 RAI was the double-ended guillotine only approach, which is I guess one attempt to sort of satisfy some of that NUREG-1829 guidance. We're still looking at though. We have a round 2 RAI as well.

MEMBER SHACK: Right, because it's dominated by the DEGB.

MR. FONG: It's kind of an extreme case.

MEMBER SHACK: Yes.

MR. FONG: Right.

MR. KEE: And that's what I tried to show in here. That's why that appeared here. Now, maybe that doesn't -- I was hoping to satisfy everyone's concern on DEBG-only where we say we don't care.

MEMBER SHACK: Well, what I'm worried about is putting the right size break in the right location. And if that break is more likely to occur in this pipe, it's more likely to occur in that location. And I think that I'm losing some of that with this approach is my concern. At least I think -- I'm still confused somewhat.

MR. KEE: So just to be clear, the pipe sizes we're talking about are 16-inch. These are all thick-walled, or RCS loop piping that are forgings that are 272, 29-inch, 31-inch and the surge line, that one location, is 16-inch. These are all big pipes.

MEMBER SHACK: Yes, okay.

MR. KEE: They're pretty much made the same way.

MEMBER SHACK: Yes, and I think that --

CHAIRMAN STETKAR: I think the concern would be a lot more if we were talking about three, four-inch pipe sizes, which is why I've been trying to push them on a single train down into that regime of pipe sizes, but it won't push that far.

MEMBER SHACK: If we only have big pipes, then big cracks can only occur in big pipes.

CHAIRMAN STETKAR: In big pipes. So maybe --

MEMBER SCHULTZ: But your question about location is still something that needs to be at least addressed in terms of is there anything with regard to that part of the question that's completely responded with the assumption here? I think it is, but I think it needs to be addressed.

MEMBER BLEY: But the only other piece to that is when you're doing 17D, take it to real small. That covers a big hunk of the containment. And if it's here or over there, it's still the same kind of stuff --

(Simultaneous speaking)

CHAIRMAN STETKAR: The precise location might -- I mean, given the volume of pipe that's that size, it may not make too much of a difference.

MEMBER SCHULTZ: And they're likely in similar types of locations.

MEMBER BLEY: And that would have made the CASA work a lot more complicated, I suppose, if you were tracking this.

CHAIRMAN STETKAR: I think as long as you're in that pipe size range, the results might not be all that sensitive --

MEMBER SCHULTZ: I agree --

CHAIRMAN STETKAR: -- until you get down a smaller one.

MEMBER SCHULTZ: -- that they might not be. I just think it needs to be a few paragraphs or a sentence

--

(Simultaneous speaking)

CHAIRMAN STETKAR: A good argument.

MEMBER SCHULTZ: -- written to draw that argument forward just for completeness.

MR. KEE: Okay. Yes, we can address that.

MR. LETELIER: If I could interject. This is Bruce Letelier from Alion. The CASA model does track those locations. And under the old implementation with the hybrid bottom-up we were accounting for those proportionalities between break types.

MEMBER BLEY: Now did it make a difference?

(Simultaneous speaking)

MR. LETELIER: -- under RoverD.

MEMBER BLEY: There's the key question.

MR. KEE: It doesn't make a difference.

MEMBER BLEY: Did it make a difference?

MR. KEE: No.

MR. LETELIER: We did both the -- we did the hybrid bottom-up weighting and we did the double-ended guillotine extreme and showed that the double-ended guillotine actually reduces failure frequencies because you're no longer allowing small breaks to exist in regions of high insulation density. When we spread the breaks out uniformly, small breaks supported on large pipes, you tend to introduce breaks in those regions that have a lot of insulation. And that's what's leading to the break -- the failures on Ernie's list.

MEMBER SHACK: Okay. But then your approach would also make the frequency of those breaks somewhat higher than it would be if I did a component by -- so it's actually somewhat conservative approach.

(Simultaneous speaking)

MR. FONG: There's been a lot of discussion whether -- this is C.J. Fong with NRR again. There's been a lot of discussion on whether the continuum approach is more conservative than the so-called double-ended guillotine-only approach. And I really think; I look at this a lot, it depends. It's very location-specific.

MEMBER SHACK: But if I put the 4-inch break in the 31-inch pipe where it hits a lot of stuff, then giving it the same frequency as I would the same size break in a smaller pipe which is higher but happens to be in a place where I don't have a lot of stuff, then it's conservative. Now, you're probably going to go through the whole CASA Grande analysis to figure out whether in fact that's true or not, but at least I see an argument.

MR. FONG: That's one of the many competing effects. And if you look at slide 60, you'll actually see that the aggregation scheme, arithmetic versus geometric, flips the whole thing around. So under the geometric scheme the continuum approach is more conservative. But if you use the arithmetic scheme, the double-ended guillotine approach is more conservative or produces a higher --

(Simultaneous speaking)

MEMBER SHACK: Well, I didn't quite understand that.

MR. FONG: There's multiple degrees of failure depending how you model it. And so trying to say up front one's more conservative than the other, you really can't do that. You have to run the actual numbers. And that's what we're asking the licensee to do so the staff has some confidence.

MR. KEE: So that's what we've tried to do in here. That's why we've done all those numbers. But it's still a -- it's very slight nuance in any case. I mean, if we were having four-inch breaks that exceed this tested amount, we wouldn't be here talking about this.

MR. MURRAY: Right. Yes. So what I got out of that is we need to make sure that when staff gets what they need to get the confidence and then state it in such a way that it can be understood by ACRS when they look at it. Is that correct?

CHAIRMAN BANERJEE: Are we ready to move on to the regulatory --

(Simultaneous speaking)

MR. WIDMAYER: We've got lots of time.

CHAIRMAN BANERJEE: It's better to finish early than to --

(Laughter)

MR. WIDMAYER: I agree.

CHAIRMAN STETKAR: That's why you're the Chairman of this meeting.

(Simultaneous speaking)

(Laughter)

CHAIRMAN BANERJEE: Okay.

MR. HARRISON: The regulatory implementation hasn't changed a whole lot with this RoverD. We're still talking about exemptions and amendment to the license. That's the same type of exemptions that we had talked about previously, and that would be to 10 CFR 50.46 Delta, the ECCS other requirements. We're not requesting an exemption to 10 CFR 50.46 Bravo for long-term cooling, but we're asking for an exemption to how you calculate the cooling.

We're using a risk-informed method. It's the methodology, not the phenomena itself.

Same thing with General Design Criterion 35, 38 and 41. The exemptions would apply to allow us to use a risk-informed methodology instead of the prescriptive deterministic methodology that's present in the General Design Criterion. And it would apply for that scope of breaks that would generate sufficient debris to exceed what was tested. So that's how we picked the exemptions.

With regard to a license amendment, the application that's currently on the docket, the November 2013 application, only has the first dash there, the risk-informed approach is a methodology change per 10 CFR 50.59. It currently does not have a proposed change to the technical specifications, however after some further dialogue with the staff and to address some questions with regard to really not wanting to use risk to determine operability, we think we can clarify that with actions in the technical specifications for the emergency core cooling system and the containment spray technical specification. We picked those two because they're the only two systems that rely on the strainers as a support system for their operability. And we simply would tie that to the -- say operability is determined by limiting the containment debris quantities to be less than what's in the STP debris analysis.

And if you exceed that amount of debris, you would take some action to implement compensatory actions. And those would be things like if you have the maintenance -- if you're doing maintenance on the emergency core cooling system, you would see if you could back out of that maintenance or not schedule maintenance on the emergency core cooling system, maintain your emergency systems at an escalated readiness, if you will. Brief operators, remind them of what their actions are in case you had a debris-related event. And then within -- the 90 days is bracketed, but based on the low frequency of this event, we would expect to have a long restoration period, somewhere in the order of 90 days to restore this to operable status or take your normal tech spec action.

We're still in discussion with the staff on how we frame that allowed outage time, that completion, if you will. We'll work our way through that, but we expect it to be a fairly extensive time.

CHAIRMAN STETKAR: Wayne, one of the -- I was reading something, so forgive me. You said one of the compensatory actions might be to have the operators be vigilant that the ECCS systems are more ready or something like that?

MR. HARRISON: No, I said just if you know that you have a debris-related issue that you would brief your operating crews on, okay, if we have the LOCA, remember here are the things you need to look for with respect to symptoms of debris and how you would --

(Simultaneous speaking)

CHAIRMAN STETKAR: What could they do about that, though? I mean, there's nothing that I can do sitting in the control room to go suck out debris.

MR. HARRISON: Well, we have an emergency response organization obviously that they're relying on. There are some things that we can --

(Simultaneous speaking)

CHAIRMAN STETKAR: You mean get ready for the melt?

MR. HARRISON: Not necessarily.

(Laughter)

CHAIRMAN STETKAR: When you talk about these compensatory actions, it's what can I do as an operator?

MR. HARRISON: And the objection of your compensatory action is just at that point in time what can I do to reduce my station risk to be more ready? If

I have a diesel scheduled for maintenance, maybe I don't want to go do that maintenance right now. These are judgmental and --

CHAIRMAN STETKAR: But if I have the debris in there, it's more than the analysis shows, it doesn't make any difference. If all the diesels work and everything works --

MR. HARRISON: Well the first thing you're going to go --

CHAIRMAN STETKAR: -- I'm in trouble.

MR. HARRISON: Well, obviously the first thing you're going to go do -- most cases we see of this where it's occurred is it's transient stuff, and you go in and you take it out.

CHAIRMAN STETKAR: That I can get.

MR. HARRISON: See, that's not --

(Simultaneous speaking)

CHAIRMAN STETKAR: That one I understand. I can go along with that.

MR. HARRISON: That's not a compensatory action, obviously. That's one that you -- but that's your reaction, I'm going to go --

CHAIRMAN STETKAR: Clean it up.

MR. HARRISON: -- clean it up, take out this transitory stuff. I'm going to do --

CHAIRMAN STETKAR: Compensatory actions might be to make sure you refill the RWST --

MR. HARRISON: Right. That's right.

CHAIRMAN STETKAR: -- a lot and pump a lot of clean water in there. That I can understand.

MR. HARRISON: Right. That's exactly right. But again, these were just thoughts at this point. We haven't --

(Simultaneous speaking)

CHAIRMAN STETKAR: But minimizing diesel maintenance, that one I don't get.

MR. HARRISON: It's just have your standby systems ready for standby so they are available.

CHAIRMAN STETKAR: But that doesn't solve the problem if all of the operating systems, regardless of whether they're all operating, are going to fail because you have too much debris. It doesn't make any difference. They could be 100 percent operable and immediately available and they're going to fail because you have too much debris in there. So trying to make them more available doesn't help the situation, does it?

MR. KEE: Can I say --

CHAIRMAN STETKAR: Yes.

MR. KEE: As we've discussed -- let's talk about a couple things: One is that tested case we had full flow through two strainers. What do we do -- what is the most likely case? We'll have three strainers in operation. If we have a diesel available, we have a loop or whatever, then we're -- what Wayne's trying to say is the availability of those three trains is maybe made more certain. Or we get out of an extended outage on a diesel, or something like that, I don't know. But what can you do? Knowing the most likely case is three trains, we've talked about, well, what if you forget to shut -- what if you forget to dump the third containment spray? So if you have three trains, that opportunity is front of the operator and he be briefed on that.

CHAIRMAN STETKAR: Okay.

MR. KEE: He can be briefed on alternative flow paths that are already in our EOPs and so on and so forth that talk about, for example, the volume control tank that's in the -- and our charging pumps are safety-related, so they can be brought in. So there are things that can be briefed and be made ready, or anticipation.

MR. HARRISON: And again, the main purpose of the technical specification change was to make sure the operators knew where they were in technical specification. I mean tech space with regard to operability. If you have this much debris, you're okay. If you have more than this much debris, you need to be in the action state. That's really where this -- the clarity that the technical specification change provides for cooperations.

The last thing I have on my set of slides is -- on slide 67, we will have accompanying changes to the updated final safety analysis report with respect to how we comply with the General Design Criteria. We will discuss RoverD and the way that works in Chapter 6 of the UFSAR. We will accommodating changes to the bases for the technical specifications for emergency core cooling system and containment spray system. And it will just help clarify the design basis. I think most of these changes should be pretty straightforward once we get underway with them.

And that completes my part of this and I'm ready to turn it over to Mike.

MR. MURRAY: So go to slide 68, please. So are ready for conclusions, Mr. Chairmen?

CHAIRMAN BANERJEE: Yes.

MR. MURRAY: So in conclusion, we feel that the RoverD process incorporates all the aspects of the debris issue: generation transport, in-core effects, deterministic testing of fiber and chemical effects, and the risk-informed evaluation portion. And continued, as we had mentioned before, as we've gone through this thee results continued to demonstrate very small risk in accordance with Reg. Guide 1.174. So those are our conclusions.

MEMBER BLEY: Mike, I have a question.

MR. MURRAY: Yes, sir?

MEMBER BLEY: Early on I think you said in your next submittal that will include all of this you're going to attach the probabilistic methodology that you had before. Did I hear that right? And if so, I'm wondering kind of why, because you're not using it.

MR. HARRISON: I don't think we -- I don't recall that we said that.

MEMBER BLEY: I thought I heard that this morning. If I didn't --

(Simultaneous speaking)

MR. HARRISON: That currently is not our intent. It will be what is needed to support RoverD.

MEMBER BLEY: Okay.

MR. HARRISON: What I've said is we've not ignored anything we've used up to this -- that may have been what you heard.

But, Bruce, did you have something to add?

MR. LETELIER: No, only that they stated

that they would append the RoverD methodology to this submittal so that you have all the details available for --

(Simultaneous speaking)

CHAIRMAN STETKAR: RoverD methodology to the submittal answering the RAIs in March?

MR. LETELIER: Correct, the --

(Simultaneous speaking)

CHAIRMAN STETKAR: As opposed to the revised LAR in June.

MR. HARRISON: Actually, there will be RoverD in both of those submittals.

CHAIRMAN STETKAR: Yes.

MR. HARRISON: But the staff will see the description in detail that we just went through today on the docket. It may be signed now.

CHAIRMAN STETKAR: But it's in response to the --

MR. HARRISON: Correct.

CHAIRMAN STETKAR: -- open RAIs right now?

MR. HARRISON: Yes.

MR. MURRAY: And we appreciate the clarifying question if there was --

(Simultaneous speaking)

CHAIRMAN BANERJEE: Who dreamt up RoverD?

That's quite a -- it's nice, R over D, right?

MR. HARRISON: There were a number of people.

(Laughter)

MR. HARRISON: And we'll leave it at that.

(Laughter)

CHAIRMAN BANERJEE: All right. So does that conclude your presentation, Mike?

MR. HARRISON: That concludes our presentation. Yes, sir.

CHAIRMAN BANERJEE: Thank you very much. I'm going to of course ask the staff to conclude, if anybody wants to make any remarks from the staff.

MR. MARKLEY: I'd like to make a comment.

CHAIRMAN BANERJEE: Yes, please.

MR. MARKLEY: This is Mike Markley. I'm the chief of the Plant Licensing Branch 4 in DORL. And some of these things that they've talked about today, particularly the tech spec change at the end, those are fairly new to us, in fact very new, have been part of the discussions over the past four years, so we have some questions to sort through. And certainly we have a context for operability that's not consistent with what they're describing here. So just want to let you know this is very early in the process for some of us in what they're changing.

CHAIRMAN BANERJEE: Thank you. Before I do the --

MEMBER SHACK: Can I just ask one more question?

CHAIRMAN BANERJEE: Yes, of course.

MEMBER SHACK: Did anyone do one of these filtration calculations where you kept a number like 0.65, which I would assume would correspond to a strainer with lots of sort of open area to see how much of it would end up on the --

MR. KEE: We've implemented -- I'm not sure -- we haven't done that. The answer to that -- short answer is no, but it's certainly obviously something we could do.

MEMBER SHACK: It just would strike me as sort of interesting to see what would happen, because we've worked so hard to get people to get big strainer, which drives that filtration number down to like 0.6.

CHAIRMAN BANERJEE: We realize the risks of doing that, too.

MEMBER SHACK: Yes, well, you can actually quantify it here --

CHAIRMAN BANERJEE: But I think the --

MEMBER SHACK: -- unless you tape up parts of the strainer.

MEMBER SCHULTZ: So, Ernie, I thought you had done that range of -- just the ends with regard to the --

MR. KEE: So he's asking a different question. So we would abandon our data and adopt a single number as sensitivity or something to say, okay, it's always -- it doesn't matter how much is on --

MEMBER SHACK: But just it would correspond to something with a big open area on the --

CHAIRMAN BANERJEE: Well, it may also -- because there's been a lot of questions about the size of the fiber and all that and how that affects the size distributions, the amount that goes through. Clearly there are issues that -- because the size relative to the hole size matters, how you distribute the fiber. So it's always interesting to know what the bounding effects are.

MR. KEE: Yes, and that's easy to do.

CHAIRMAN BANERJEE: Yes. I think before we ask for comments though, I should open the discussion to public comments. So, Derek, are we able to receive public comments?

MR. WIDMAYER: We can from the room.

CHAIRMAN BANERJEE: Well, yes, so let's start first with the room. Are there any members of the public who wish to comment? Not question. Just comment.

(No response)

CHAIRMAN BANERJEE: So now anybody on the phone who's a member of the public, please identify yourself and please comment if you wish to. Is there anybody out there who would like to?

(No response)

CHAIRMAN STETKAR: Let me try something. For those of you who are not familiar with our high technology system, if there's anyone out there listening in, could you do us a favor and just say hello.

MEMBER CORRADINI: Hello from Corradini.

(Laughter)

CHAIRMAN STETKAR: Believe us, this is the only way we can actually confirm that we can hear you.

CHAIRMAN BANERJEE: Thank you.

MEMBER CORRADINI: I just got the separate line open.

CHAIRMAN STETKAR: Okay. But I heard a second -- someone else. Somebody else said hello.

PARTICIPANT: Hello again.

CHAIRMAN STETKAR: Good. Thanks. Thank

you.

(Laughter)

CHAIRMAN BANERJEE: So hearing no comments from the public, I would like to now turn this over back to the Committee for comments. So we'll start with -- you want to leave that open? I mean, close the comments back to us. So, Steve, why don't we start with you?

MEMBER SCHULTZ: I appreciate the presentations today. I have had the opportunity to listen to some of the previous discussions with the Committee and I've liked what I've heard today in terms of a revised approach. And we've had a number of questions answered. And we've got more information that's going to be flowing in, including the revised documentation for it.

So my only closing comment would be that I would encourage you not to presume -- as you write that June report, or application as it were, to presume that everyone understands what's been done over the past four years, but rather focus -- because I think this is very important work. And in order for it to be reviewed in a timely fashion as well as be used going forward in the very best way, the write-up ought to be done in a fashion that it captures this methodology and all of the aspects of it and doesn't -- when Dennis asked his question about are you going to attach what was done before, I'm glad to hear that you're not.

(Laughter)

MEMBER SCHULTZ: All I'm saying is try to leave that behind and don't presume that everyone understands what's been done before, but rather capture it all in one place of this methodology and do it in an integrated fashion so it's well understood. That's my comment.

CHAIRMAN BANERJEE: Thanks. Dennis?

MEMBER BLEY: I do appreciate the briefings today. They helped me understand a little better how you're doing this and look forward to seeing the submittals. I'm personally a little disappointed that we abandoned the other approach, but I can understand why that's happened. I guess that's all.

CHAIRMAN BANERJEE: John?

CHAIRMAN STETKAR: Yes, I don't have anything to add. I'm a little surprised by what I heard today in terms of the conclusions, but I have to think about that. Not in terms of the overall conclusions. I'm surprised that smaller breaks don't give you problems, especially with the single-train operating. But I don't understand enough about the debris generation and I don't understand enough about the locations. So as Steve, I want to make sure that the overall summary makes that pretty clear so that there's confidence that you've actually looked at the entire spectrum of break sizes and locations and in particular the effects on that single train, because that's kind of an extrapolation, I think. Other than that, thanks.

CHAIRMAN BANERJEE: Ron?

MEMBER BALLINGER: Nothing really to add. I'm got to go back and try to understand better than -- well, as well as some of the other people in the room about how you get to the amount of debris that's produced. And that's something I have to go read about that. But it was a great presentation. Thank you.

CHAIRMAN BANERJEE: Bill?

MEMBER SHACK: It was a very interesting day. I think one thing that would be nice to see would be a few more results of the analyses to show how debris was generated by certain kinds of breaks placed around -- just for illustrative purposes to -- then we can go off to the big breaks that make lots of stuff. But I think it would be sort of interesting to see that spectrum a little bit.

MR. KEE: Yes, we took that out.

(Laughter)

MR. KEE: That's a lot.

MEMBER SHACK: Well, I'm sure -- I mean, you've done it. It's only a matter of writing it up.

MR. KEE: And you'll see those for both the single-train case and the two-train case in the submittal. Not the submittal. The RAI response, yes.

CHAIRMAN BANERJEE: Joy?

MEMBER REMPE: For the part I was here for I have no additional comments.

(Laughter)

MEMBER REMPE: I had another commitment this morning.

CHAIRMAN BANERJEE: You only turned up for the afternoon.

MEMBER SHACK: Mike sends his comments in that he was out for class a good portion of the time, but he was -- sort of echoes Steve's comments that he'd like to see sort of a -- one coherent presentation of the results without sort of assuming that you're familiar with the whole gory history.

CHAIRMAN BANERJEE: Right.

CHAIRMAN STETKAR: Well, and in truth if I have to be candid, the last report looked like it was a bunch of white papers authored by individual consultants slapped together with a title page on it.

It didn't hang together all that well.

MEMBER BLEY: Which is part of the reason there were so many ambiguities.

CHAIRMAN BANERJEE: But I think it's becoming more coherent and the story seems to hang together. And I'd like to join my colleagues in thanking you, and also thanking the staff, for making a clear and very, very useful presentation. I think it's really taken us forward a lot. We're beginning to understand what you're trying to do and the approach is beginning to gel. You can see it coming together now. And it will be very useful if it actually -- between you and the staff you work out a position which allows you to go forward on this. There will be many plans to look at this and follow I think.

It's very important that the sequence of exactly what you're doing be put together in a logical whole; not an H-O-L-E, but a W-H-O-L-E --

(Laughter)

CHAIRMAN BANERJEE: -- so that we really understand the steps of how everything relates to everything else and all hangs together. There's RELAP 5 calculations going on. There's all sorts of -- there's a little model here which is circulating the stuff, taking it out. There's a big jigsaw puzzle. So it all needs to sort of fit together.

And I'm sure that the staff will be doing confirmatory calculations of all the more critical paths and getting things checked independently so that when we see it eventually we will have a lot of technical confidence in what's going on, which is very important because some of the results are surprising and it's in a way that others have tried and not been able to succeed. So we want to understand why you're successful in doing something, like relieving some of these limits and so on. So at the moment it all seems promising. So let's follow up.

I don't when you're going to come back to us next. I guess --

MEMBER BLEY: August.

CHAIRMAN BANERJEE: Is it August? Okay. And that will still be just informational, right?

MR. WIDMAYER: Yes.

CHAIRMAN BANERJEE: But then we won't have the SE. It will be what --

MR. WIDMAYER: That's correct.

CHAIRMAN BANERJEE: Yes, it will be another year or so down the road. Okay. But I think it will be good to keep us informed about what's going on. Okay?

And so with that, I think I'd just like to thank everybody once again and adjourn the meeting.

(Whereupon, the above-entitled matter was adjourned at 2:48 p.m.)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

ACRS Subcommittee Meeting

NRC Staff Review Status of South Texas Project Risk-Informed Approach for Resolution to Generic Safety Issue - 191

March 18, 2015

Introduction

Lisa M. Regner

Senior Project Manager
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

STPNOC Background

- Risk-Informed approach as a pilot plant
- Pre-licensing public meetings in 2011 and 2012
- Licensing Action Submittals
  - January 2013, Exemption request for risk-informed approach
  - June 2013, Revised exemption request and license amendment
  - November 2013, Revised submittal to correct errors
  - June 2015, Revised submittal to change methodology
- Requests for Additional Information
  - April 2014, Round 1
  - March 2015, Round 2

Status and Schedule

- Recent Public Meetings
- Regulatory Audits
- Environmental Assessment
- Upcoming STP Submittals
- ACRS Meetings

Outstanding Technical Issues

- Application completeness and consistency
- Unanalyzed accident scenarios
- Use of correlations
- Debris generation and transport
- Validation of models

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Questions?

STP Risk-Informed Approach to GSI-191

ACRS Joint Thermal Hydraulic Phenomena and Reliability and Probabilistic Risk Assessment Subcommittee Meeting

March 18, 2015

STP Agenda

- Introduction of Risk over Deterministic (RoverD) Assessment
- Deterministic Element
- Risk Element
- Regulatory Basis
- Conclusions

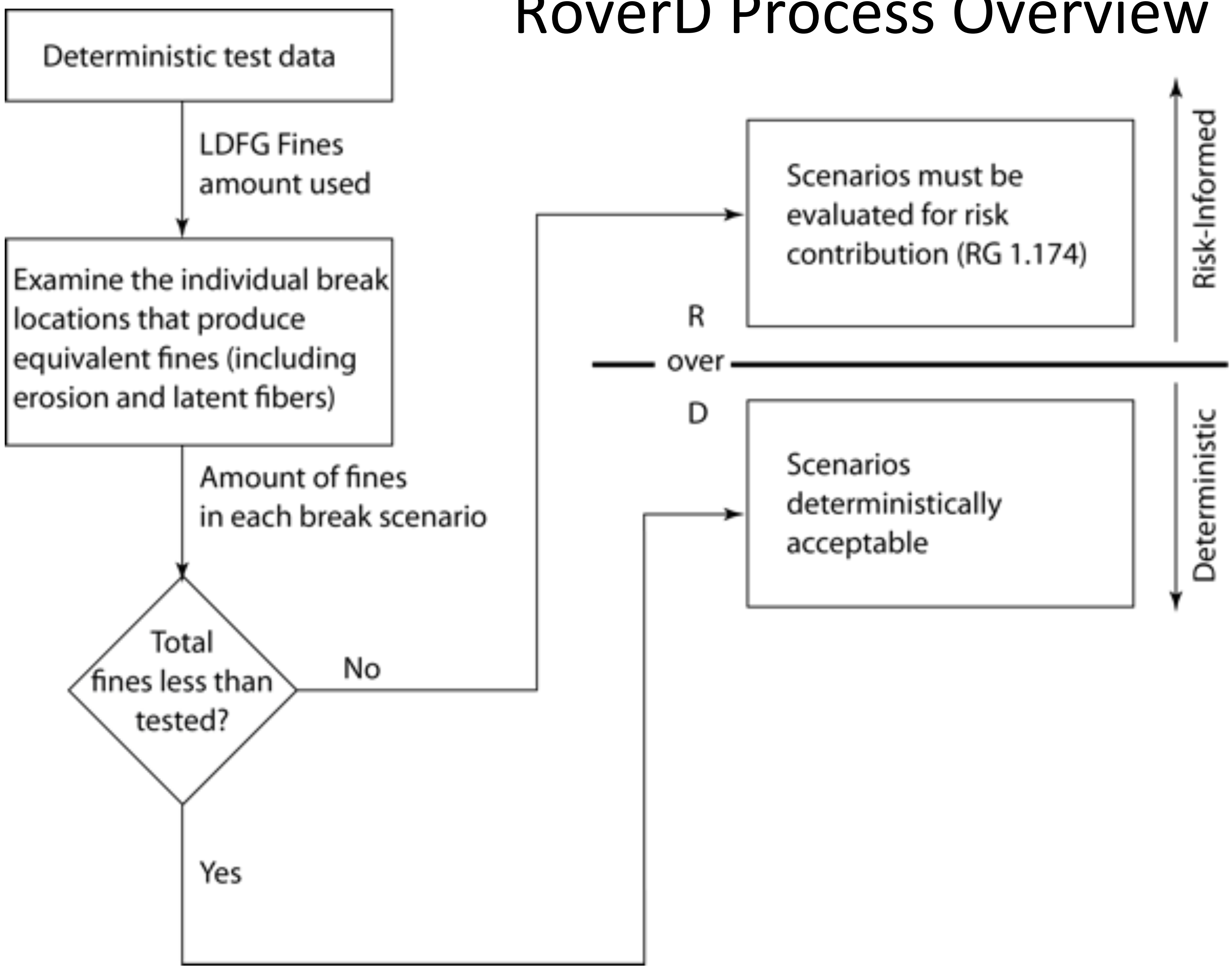
Introduction to RoverD Assessment

- Revised STP methodology uses a deterministic baseline and shows that the risk above that baseline is very small (RoverD)
  - Deterministic plant-specific testing establishes baseline for addressing debris effects identified in GSI-191 and GL2004-02
  - Risk-informed element relegates to failure LOCAs not bounded by the deterministic testing
    - Uses NUREG 1829 to quantify ΔCDF
    - Application of RG 1.174 criteria shows risk is very small
- RoverD is a less complex approach than original submittal and easier to use

High Level Overview

- Assume all breaks that can introduce more fine fiber than tested lead to core damage
- Screen the spectrum of break scenarios at all weld locations
- Find set of smallest breaks that introduce more fine fiber to the pool than was tested
- Assume all larger breaks at the same location will also exceed fine-fiber limit
- Add cumulative frequency of these events to determine CDF

RoverD Process Overview



Deterministic Elements of Risk Over Deterministic Analysis (RoverD)

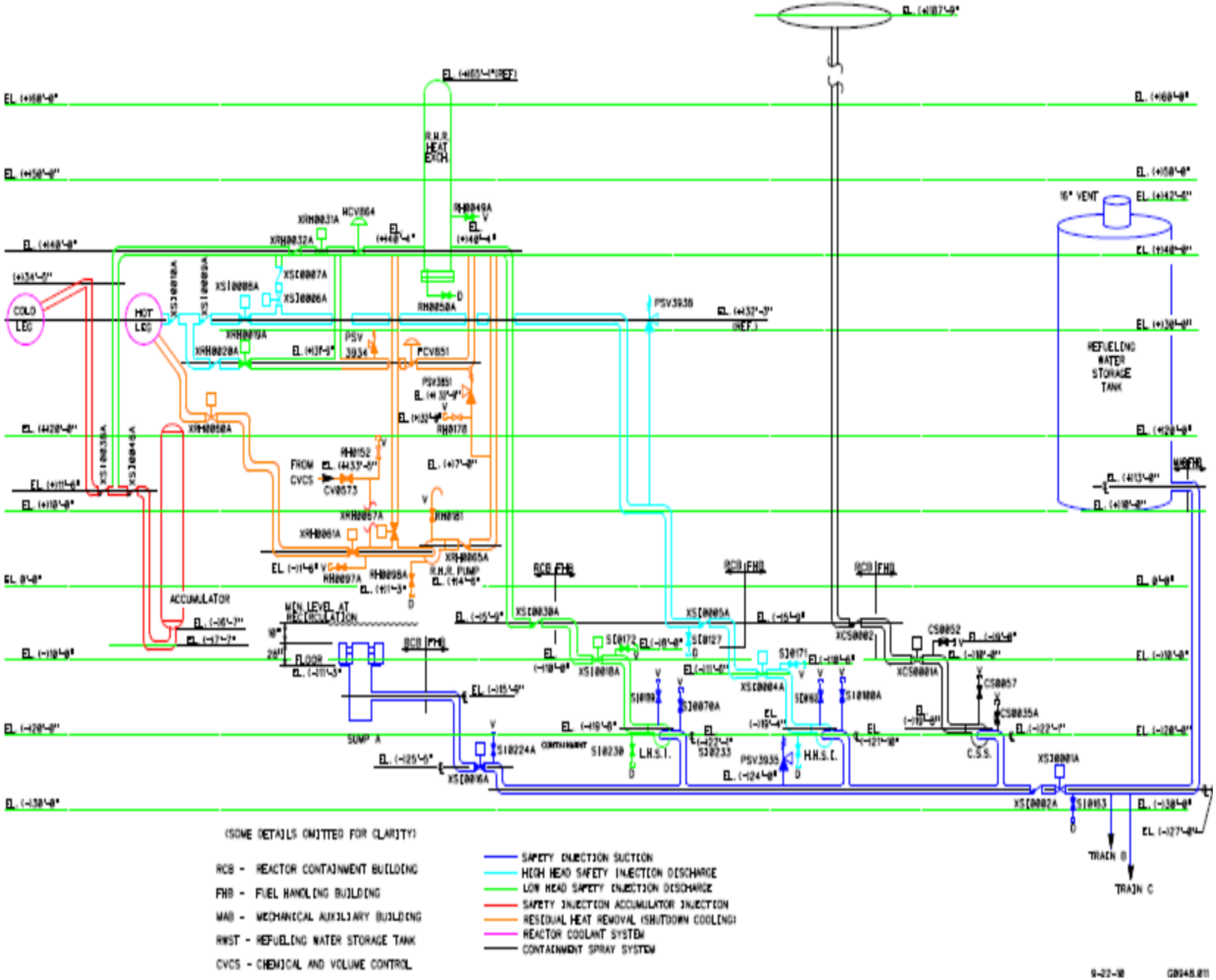
Wes Schulz

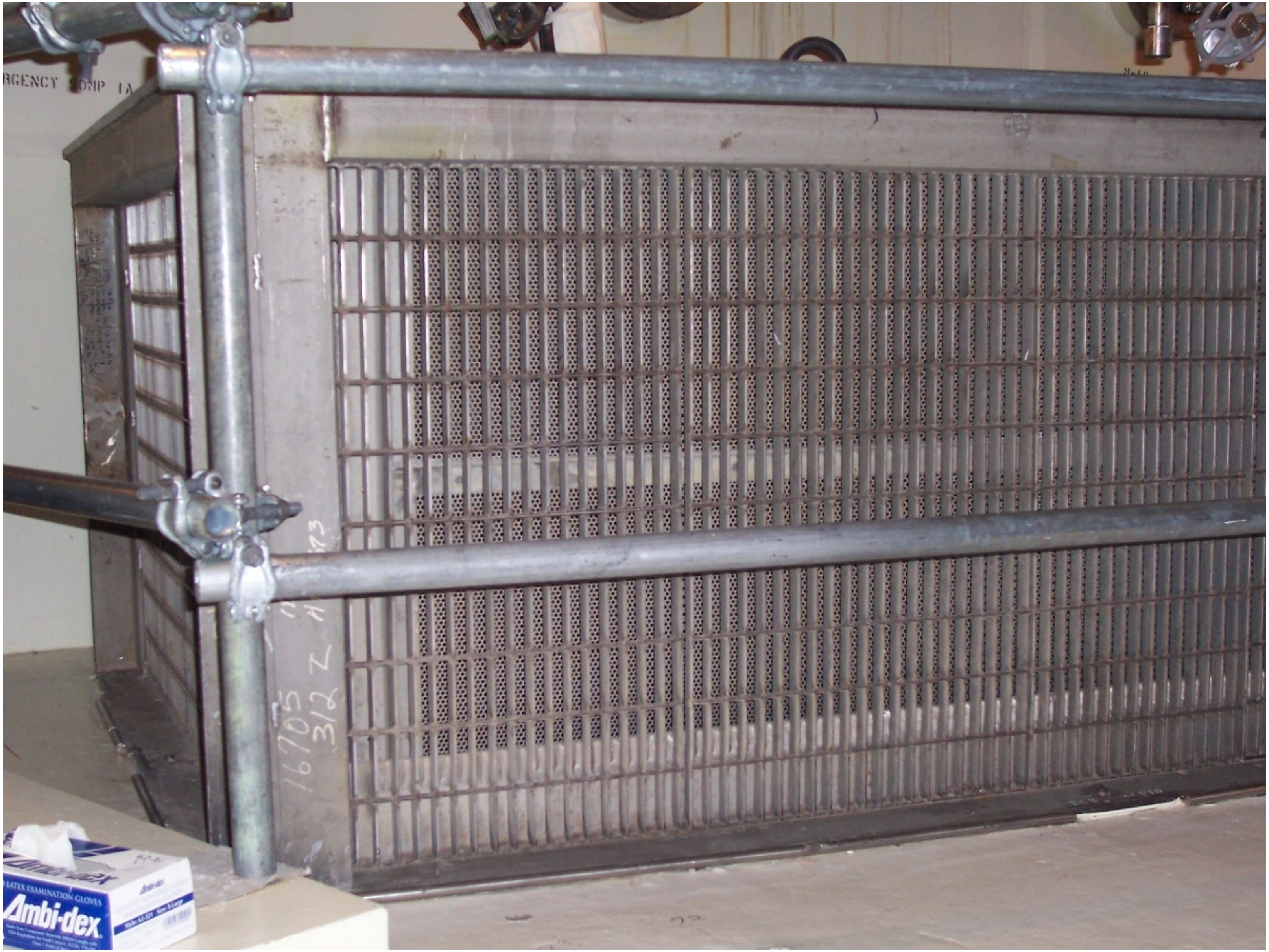
South Texas Project Nuclear Operating Company

Overview

- STP Background
- Role of Flume Testing
- Deterministic Analysis Overview
  - Elements of GL 04-02 Response Content Guidance
  - Emphasize chemical surrogate treatment
- Test Configuration and Results
- Interpretation / Application of Test Results

STP TRAIN A


SPRAY RING (LOWEST OF 4)
R.H.R. HEAT EXCH
COLD LEG
HOT LEG
ACCUMULATOR
REFUELING WATER STORAGE TANK
16" VENT
FROM CVCS
R.H.R. PUMP
MIN LEVEL AT RECIRCULATION
FLOOR
SUMP A
L.H.S.I.
H.H.S.I.
C.S.S.
CONTAINMENT
TRAIN B
TRAIN C
(SOME DETAILS OMITTED FOR CLARITY)
RCB - REACTOR CONTAINMENT BUILDING
FHB - FUEL HANDLING BUILDING
MAB - MECHANICAL AUXILIARY BUILDING
RWST - REFUELING WATER STORAGE TANK
CVCS - CHEMICAL AND VOLUME CONTROL
SAFETY INJECTION SUCTION
HIGH HEAD SAFETY INJECTION DISCHARGE
LOW HEAD SAFETY INJECTION DISCHARGE
SAFETY INJECTION ACCUMULATOR INJECTION
RESIDUAL HEAT REMOVAL (SHUTDOWN COOLING)
REACTOR COOLANT SYSTEM
CONTAINMENT SPRAY SYSTEM


Ambi-dex


04/25/2007


04/25/2007


04/25/2007


11/09/2009


RH
FROM RC FILTER 2A
TO RHR PUMP 2A SUCTION


2-SI-0010B
Q2-1387
STP UNIT 2
LOT BS-5-88
RC 123

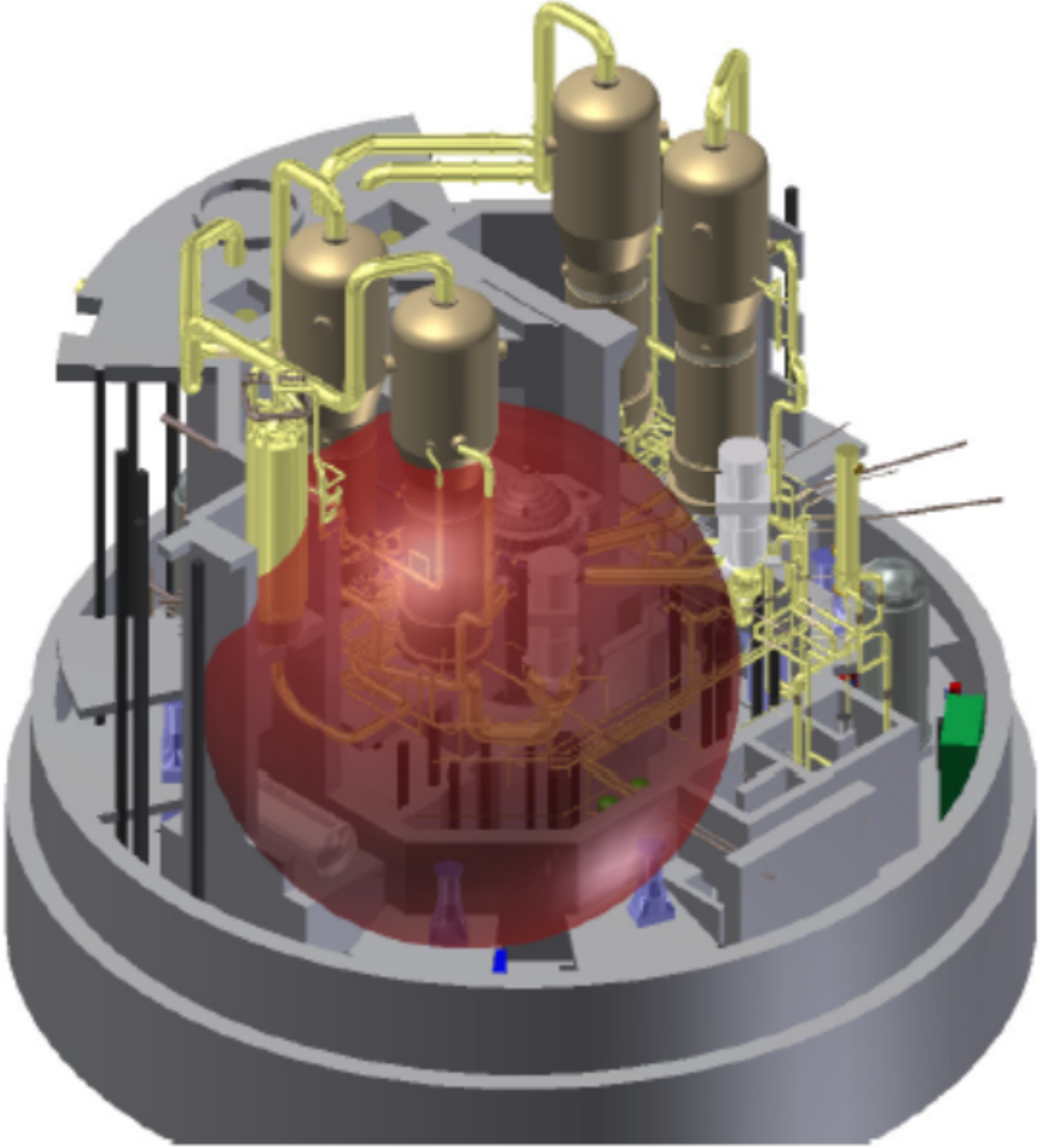


Figure 5.4.1 – Illustration of 17D Nukon ZOI for a 31" DEGB

Role of Flume Testing

- Available strainer performance testing addresses majority of failure concerns deterministically
- July 2008 flume tests designed to satisfy GL-04-02
  - Challenging fiber load on 2 trains only
  - Conservative particulate
  - 30-day WCAP chemicals (with continuous spray)
- Successful test satisfies failure concerns up to the level of the tested debris loading
- Direct comparison of break spectrum to test results eliminates need for head-loss correlation

Purpose of STP Flume Testing

- Demonstrate replacement strainer performance under design basis debris loads
- Deterministic guidance of NEI 04-07 largely used to establish loads and performance goals
  - Review each element of response guidance
- Original "test for success" objective now interpreted on spectrum of LOCA event frequency
- Focus on July 2008 STP-specific test

Basis for STP-Specific Testing

- Approved engineering calculations were prepared to address each element of the GL-response content guidance
- Quantitative strainer-performance metrics were established for each element of the guidance
- Flume tests of full-scale strainer module were performed using representative of STP-specific debris under large break conditions

Elements of Nov 2007 GL 04-02 Response Content Guidance

1. Break Selection
2. Debris Generation (ZOI)
3. Debris Characteristics
4. Latent Debris
5. Debris Transport
6. Head Loss and Vortexing
7. Net Positive Suction Head
8. Coatings Evaluation
9. Debris Source Term
10. Screen Modification Package
11. Sump Structural Analysis
12. Upstream Effects
13. Downstream Effects
14. Chemical Effects

Analysis Methods Overview

1. Break Selection

NEI 04-07 break criteria were used to define debris loads used in the July 2008 Test

<u>Break Criteria</u>

1) Breaks in the RCS with the largest potential for debris
2) Large breaks with two or more different types of debris
3) Breaks in the most direct path to the sump
4) Medium and large breaks with the largest potential particulate debris-to-fibrous insulation ratio by weight
5) Breaks that generate an amount of fibrous debris that, after transport to the strainer, could form a uniform layer (approx 1/8" thick) that could subsequently filter sufficient particulate debris to create a relatively high head loss referred to as the "thin-bed effect"

Analysis Methods Overview (cont)

2. Debris Generation ZOI

- Nukon and Thermal Wrap are the largest contributors
  - 7D ZOI contributed approximately 192 lbm of fine fiber
- Important parameter for the RoverD assessment is the amount of fine fibrous debris used in the test

Analysis Methods Overview (cont)

3. Debris Characteristics
   - Debris characteristics analyzed for July 2008 testing did not deviate from NRC approved guidance.
4. Latent Debris
   - Latent debris amounts used during July 2008 testing were assessed from Unit 1 and Unit 2 walk downs following the protocol of NEI 02-01.
     - Debris in each building was found to be less than 165 lbm
     - 200 lbm was conservatively assumed
     - 15% of latent material found was assumed to be fiber

Analysis Methods Overview (cont)

5. Debris Transport

   – Transport methodology used to determine debris amounts available to the sump was based on NEI 04-07 guidance, and refinements suggested in the SER.

     - 95% of generated fines transported (ML083520326 Table 21)
     - 1% of destroyed large and small pieces were added as eroded fines

Analysis Methods Overview (cont)

6. Head Loss and Vortexing
   - PCI performed strainer qualification calculations (TDI-6005-07) with DBA flow rates and concluded
     - No vortexing will occur
     - Air ingestion will be less than 2%
     - Void fraction will be equal to or less than 3%

7. Net Positive Suction Head

– Calculations were performed by STPNOC (MC-6220) and PCI (TDI 6005-06) that used max flow rates and standard assumptions to determine:
  - NPSH Available (which excludes the strainer and debris) and NPSH Required for the LHSI and HHSI and CS Pumps
  - Clean Strainer Head Loss
  - Debris Head Loss is based on the Strainer Testing
  - NPSH Margin (defined as NPSHA – NPSHR) is greater than the Total Strainer Head Loss. At the start of recirculation (267°F), the CS Pump has the lowest NPSH Margin of 5.6 ft. compared to the other pumps which is still more than the Total Strainer Head Loss of 3.8 ft.

Analysis Methods Overview (cont)

8. Coatings Evaluation

– Qualified coatings damaged from Loop C 31" DEGB on the RCS crossover line was chosen for the July 2008 test (ALION-CAL-STPEGS-2916-002 Rev. 3.)
  - Break was selected because of the large amounts of steel coatings destroyed at this location
  - Qualified coatings were examined with a ZOI radius of 5D based on WCAP-16568-P.
  - Destroyed as 10-μm particulates and epoxy chips
  - Acrylic surrogate used during testing

Analysis Methods Overview (cont)

9. Debris Source Term

- STPNOC procedure to maintain containment integrity with respect to potential sump debris sources. Visual inspection of the affected areas at completion of every containment entry at power to verify no loose debris
- STPNOC design change process ensures new insulation material that differs from the initial design is evaluated. Process also looks at coatings used inside containment, evaluation of added metals such as aluminum, evaluation of impacts on post-LOCA recirculation flow paths

Analysis Methods Overview (cont)

10. Screen Modification Package
    - Sump screen above each pit was removed and replaced with strainers
    - Each sump has two 5-module assemblies; one 4-moduleassembly and one 6-module assembly
    - New strainers have 1818.5 sq ft per sump (old design was 155.4 sq ft)
    - Only modifications to the plant were new strainers and removal of Marinite insulation
11. Sump Structural Analysis
    - Strainer and strainer component seismic design margins are adequate using code allowables

Analysis Methods Overview (cont)

12. Upstream Effects

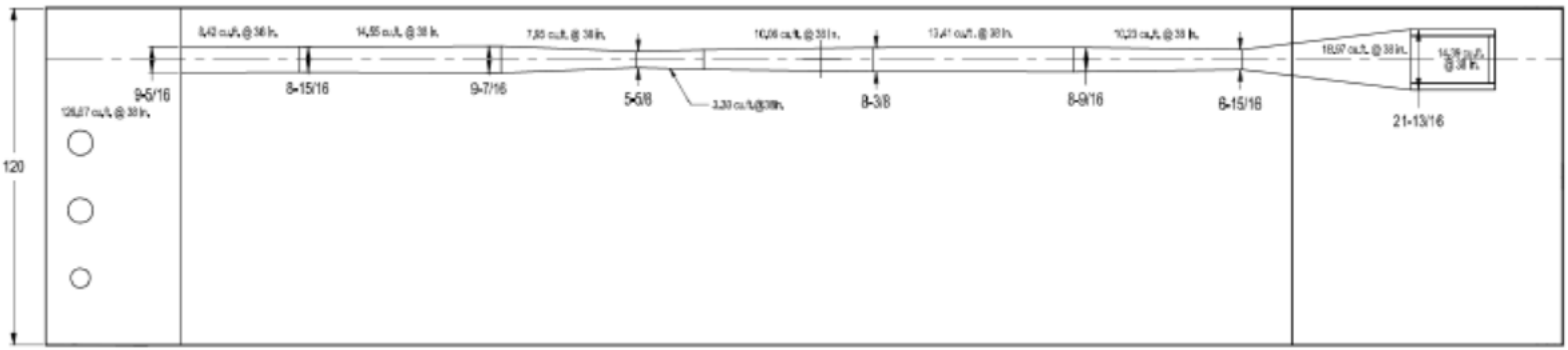
- Upstream flow conditions were evaluated for the possibility of upstream coolant flow choke points
  - Most insulation is located above the 19' elevation
    - The majority of debris will be trapped at this elevation
    - This elevation will not become a choke point because fluid flow has potential grated flow paths from this elevation
  - Flow in the recirculation pool will not be choked because the flow path around the secondary shield wall to the sumps is open

Analysis Methods Overview (cont)

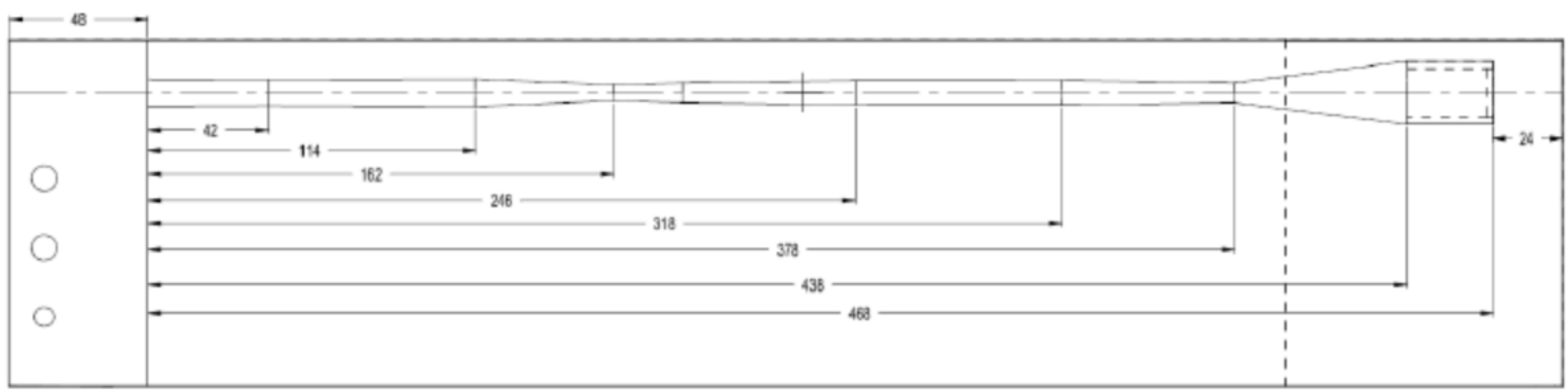
13. Downstream Effects
    - Evaluation for blockage and degradation of components downstream of the sump was performed in accordance with WCAP-16406-P-A.
    - It was determined that all ECCS and CSS components evaluated for STP can accommodate debris bypass without blockage

STP Flume Test Description

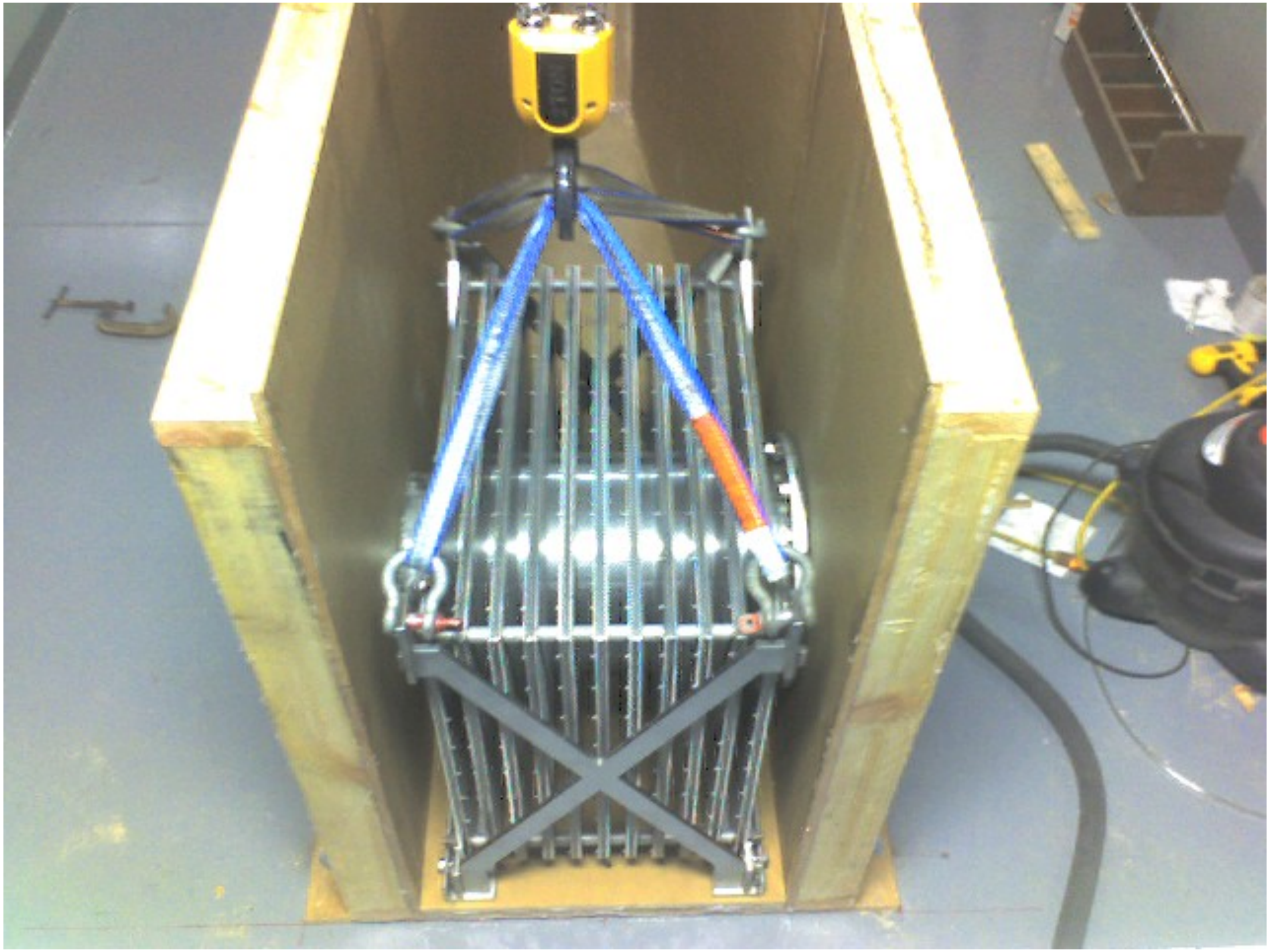
- July 2008 flume test at Alden Research Laboratory
- One full-scale STP strainer module at maximum flow
- Fiber, particle, and chemical loads scaled for 2 trains (out of 3) operating
- Flume channel designed to emulate approach velocity and turbulence



Lengthwise Dimensions



Widthwise Dimensions




OFFICE

STP ECCS strainer test parameters

1. LDFG fine (191.78 lbm) and small (380.35 lbm) fibers
   - 24.96 lbm latent fine fiber
   - 166.82 lbm insulation fine fiber
   - 380.35 lbm smalls (with fines removed)
2. Particulates, Microtherm® and Marinite® board particulates, latent dust and dirt
   - 33 lbm Microtherm® powder
   - 182.7 lbm powdered Marinite® board
   - 141.1 lbm dust and dirt
3. Chemical precipitates representing 30 days of containment spray operation (1,934 lbm chemical precipitates)
   - 1,575 lbm AlOOH, (1,432 lbm $NaAlSI_3O_8$, 143 lbm AlOOH)
   - 359 lbm $CaPO_4$
4. Coatings, zinc, epoxy, polyamid primer, alkyds, baked enamel
   - 1,368 lbm zinc powder
   - 582 lbm acrylic powder
   - 106 lbm acrylic chips (1/64" – 1/4")

Debris Preparation

- Fiber
  - Debris preparation with water jet separation
- Particulates
  - Calcium Silicate (Marinite) insulation present in test has since been removed from the containment building
  - Latent debris as described
  - Failed coatings as described

Surrogate Chemical Products

- Tested inventory exceeds total estimated using WCAP-16530-NP for predicted scenarios
- Continuous spray for 30 days (vs 6.5-hr nominal)

Chemical debris	lb_m		
	Strainer testing Design Basis	WCAP-16530-NP Max Volume (30 day spray)	WCAP-16530-NP Min Volume (30 day spray)
Sodium Aluminum silicate	1432	**1432**	1098
Aluminum Oxy hydroxide	143	79	**143**
Calcium Phosphate	359	**359**	291
Total load	1934	1870	1532

Flume Test Head Loss

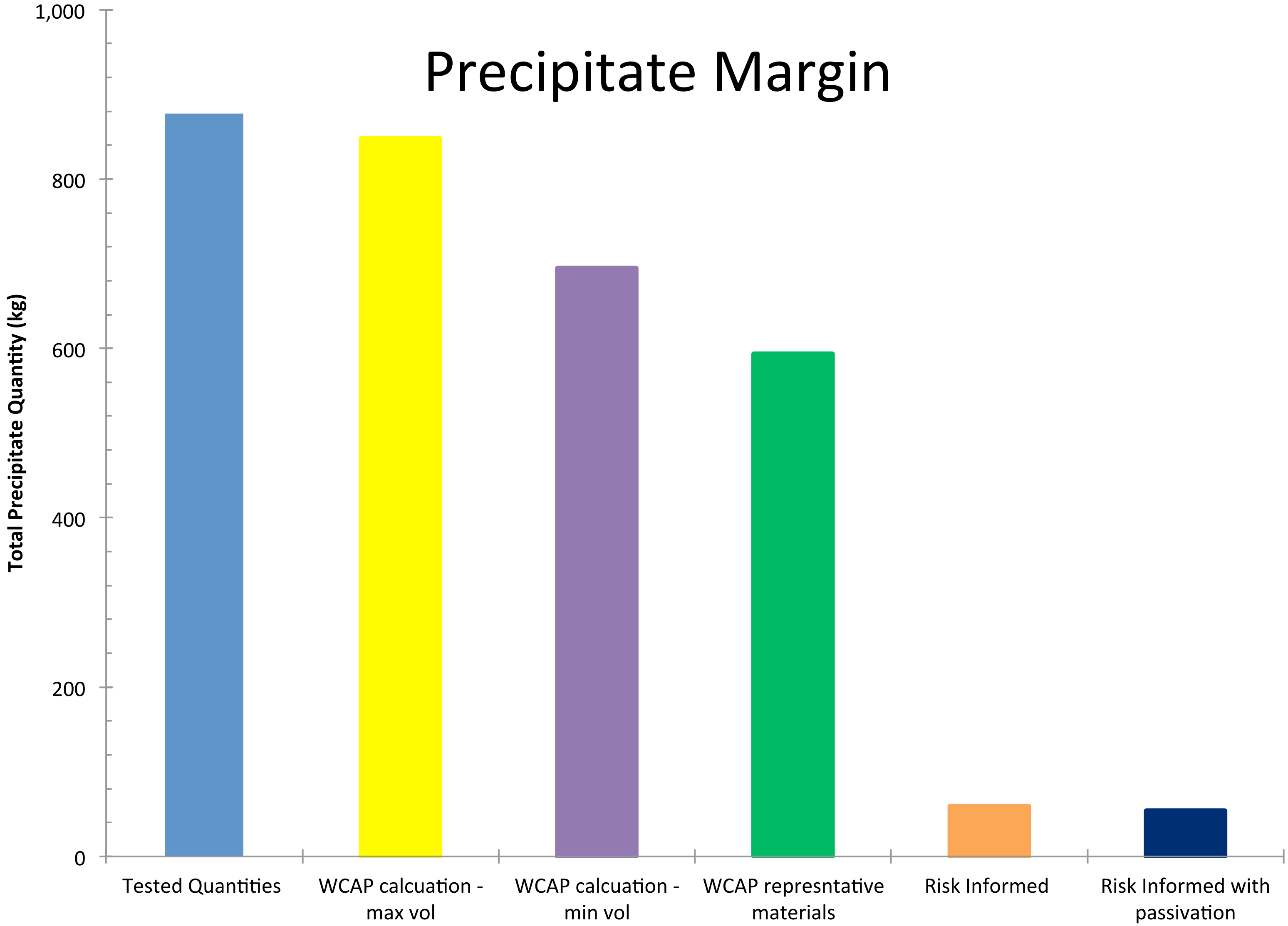
- Tested debris head loss stabilized at 9.1 ft with full flow at 116°F
- Approximately half of head loss was due to chemical precipitates

Observations

- All performance goals set by engineering analysis were met
- Representative settling of debris allowed fine fiber to arrive at strainer
- Large quantity of particulate in combination with chemical load caused thin-bed filtration conditions
- Debris preparation and introduction procedures acceptable

STP-Specific Chemical Test Results

- Long-term corrosion tank testing under STP prototypical conditions show no evidence of chemical precipitation from bulk solution
  - ICET-2 and recent CHLE series, both at UNM
- Quantities of chemical surrogate projected and tested are extremely unlikely to occur
  - No credit taken for this under risk-informed resolution



Precipitate Margin
Total Precipitate Quantity (kg)
1,000
800
600
400
200
0
Tested Quantities
WCAP calcuation - max vol
WCAP calcuation - min vol
WCAP represntative materials
Risk Informed
Risk Informed with passivation

Application of Test Results

- Assume all breaks that can introduce more fine fiber than tested lead to core damage
- Screen the spectrum of break scenarios at all weld locations
- Find set of smallest breaks that introduce more fine fiber to the pool than was tested
  - Consider debris generation, transport to pool and erosion in pool
- Assume all larger breaks at the same location will also exceed fine-fiber limit
- Add cumulative frequency of these events to determine CDF

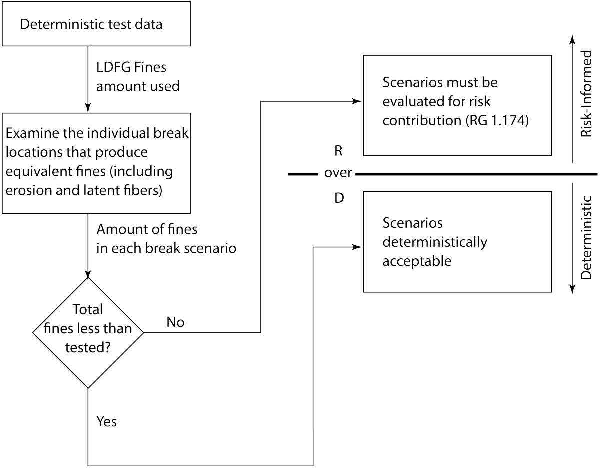
STP Risk over Deterministic (RoverD):

Test-Based Debris Risk Assessment

RoverD motivation

1. Reduce reliance on analysis
   - Correlations may have epistemic uncertainty that is difficult to quantify
   - Complexities in the engineering analysis may make results less ‘transparent’
2. Reduce scope of review
   - Deterministic test data used to screen out many scenarios
   - Risk-based review scope limited to fewer scenarios
   - Use of test data consistent with (for example) fuel testing approach by establishing a limit for debris loading
3. Add confidence to conclusions regarding risk significance
   - Relegates *ALL* failures above the deterministic threshold to core damage
   - Deterministic test produces a conservatively high threshold

RoverD flow charts



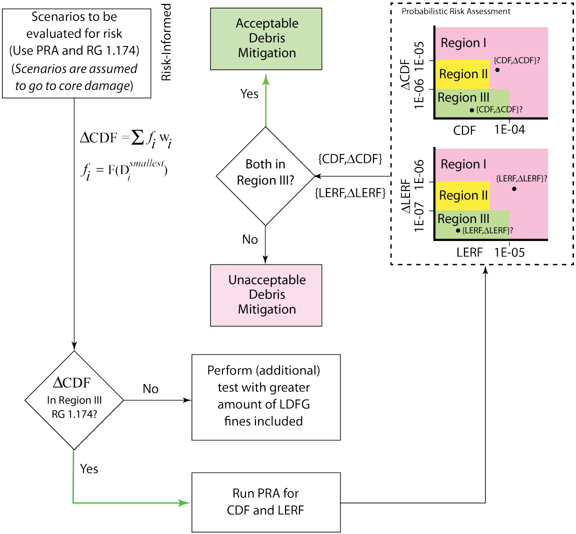
Results of break location & debris analysis

1. CASA Grande is used to exhaustively sample break size & orientation at each location and sum:
   - The amount of fine debris generated and transported
   - The amount of fine debris from latent debris
   - The amount of debris from fiber erosion
2. For each location, find out if the amount of fine fiber transported to the sump is more than the tested amount:
   - If not, record the amount created for a DEGB case for margin analysis (Deterministic category)
   - If so, record the smallest break size that exceeded the tested amount for risk analysis (Risk-informed category)

Results of break location & debris analysis

1. Two- or three-train scenarios in the deterministic and risk-informed categories (628 total Class 1 weld locations analyzed):
   - 45 locations are in the risk-informed category
   - 583 locations are in the deterministic category
2. Single train scenarios are also included in the evaluation

RoverD flow charts

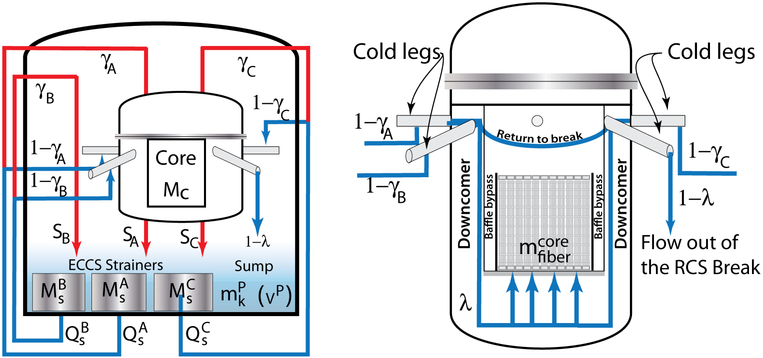


RoverD method overview

1. Use deterministic strainer test data
   - Coatings failure, chemical effects head loss, fiber loading head loss consistent with deterministic approaches
   - Note amount of fine debris from break, latent fiber, and erosion
2. Use deterministic core fiber loading data
   - Coatings failure, chemical effects head loss, fiber loading head loss consistent with deterministic approaches
   - Determine the amount of fiber (based on the amount available from above) bypassed to the core
   - Ensure the amount bypassed and collected on the core is less than the acceptable tested amount
3. Obtain the smallest break size from the CASA Grande generation and transport methodology at each weld that produces more fine fiber in the sump than in the strainer test (these are the risk-informed scenarios)
4. Derive a total failure frequency based on the smallest break sizes from NUREG 1829 to assign to ΔCDF and ensure the total ΔCDF is in Region III of RG 1.174
   - Ensure ΔLERF (using the PRA with the ΔCDF) is in Region III of RG 1.174
   - Ensure defense in depth and safety margin requirements of RG 1.174 are met

Fiber penetration uncertainty analysis

Containment flow paths and nomenclature

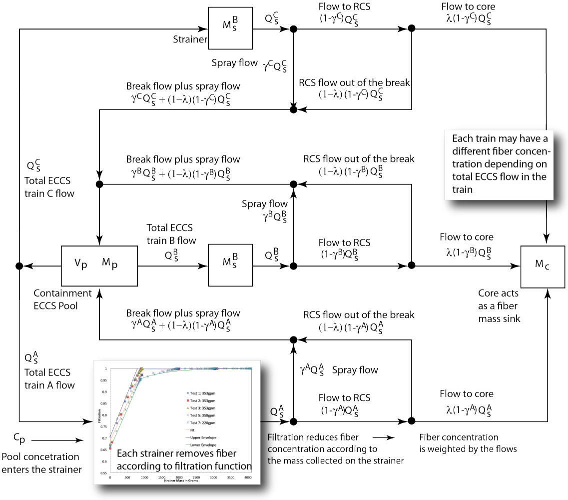


Fiber mass conservation

As showing the previous slide, the fiber mass is conserved at three locations, the ECCS sump pool, the strainers, and the core. The flow network that supports the mass conservation is shown on the following slide and can be described with time-dependent mass conservation equations shown in further slides.

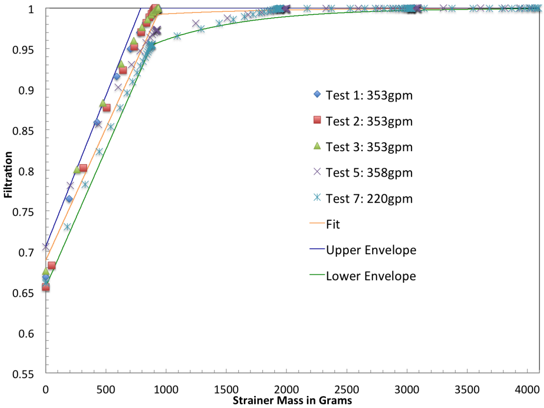
Because of the filtration function associated with the strainers' ability to capture and retain debris, the conservation equations are non-linear. The filtration function shown in graphical form as well.

Fiber mass conservation



Fiber penetration measured data

The filtration efficiency was measured for a prototypical module and the data are shown plotted against accumulated strainer fiber with bounds of uncertainty



Fiber mass conservation

Fiber mass conservation equations (based on previous figure). Equations are implemented in a Python routine that uses "lsoda" from the scipy.integrate.ode class library.

$$\frac{d}{dt} M_s^k(t) = Q_s^k(t) C_p(t) f(M_s^k(t)),$$

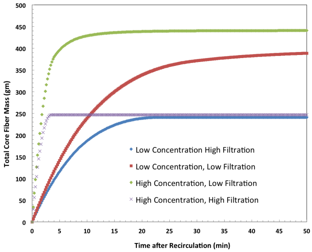
$$\frac{d}{dt} M_c(t) = Q_c(t) C_p(t) \frac{\sum_k \left[\left(1 - f(M_s^k(t))\right) \left(1 - \gamma^k\right) Q_s^k(t) \right]}{\sum_k \left[(1 - \gamma^k) Q_s^k(t) \right]},$$

$$0 = \frac{d}{dt} M_p(t) + \frac{d}{dt} \sum_k M_s^k(t) + \frac{d}{dt} M_c(t).$$

Fiber penetration sensitivity

Upper lower and limits of fiber concentration were tested at the high bound of filtration uncertainty and low bound of filtration uncertainty. Uncertainty calculations show that the maximum (15 gm/FA) will not be reached $(441\ gm)/(193\ FA) \ll 15$ gm/FA

$C_p(t=0)$ gm/GAL	**lower**:$f(M_s^k(t=150 \text{ min.}))$	**upper**:$f(M_s^k(t=150 \text{ min.}))$
High (0.832)	441	247
Low (0.158)	400	241



ΔCDF

1. RoverD screening stage: For each weld location with a break producing more fine fiber in the sump than tested, record the smallest break size (note that some locations may not have a scenario exceeding the tested fiber fines)
2. Determine ΔCDF from NUREG 1829 LOCA frequencies based on the following principles:
   - In the limiting case for which every weld and every break above (smallest) diameter x is considered "bad" (that is, at that break size, more fines come to the sump than were tested), the break frequency should equal to the NUREG 1829 exceedence frequency at x,
   - RoverD should depend on the number of welds in the RoverD risk-informed category. In particular, frequency should increase if welds are added to the set of "bad" welds.
3. We refer to this as "top-down" adherence to NUREG 1829 published frequencies

Plant ΔCDF analysis (strainer)

For any weld i in pipe a category (indexed by n) with a smallest break size D_i^{small} the frequency for all pipe categories, each having TW_n total locations:

$$F(D_i^{small}) = \frac{f(D_i^{small})}{TW_{Cat(D_i^{small})}}.$$

$Cat(D_i^{small})$ is the pipe category corresponding to D_i^{small}. For example, if Category 1 is 1-inch pipes and category 2 is 2-inch pipes, then for a break of 1.75in, $Cat(1.75in) = 2$.

If R_n is the set of all welds in the risk-informed category associated with pipes of category n then, the frequency of unacceptable events due to weld breaks in pipes of category n can be written as:

$$\sum_{i \in R_n} F(D_i^{small}).$$

The overall frequency (Φ) of events in the risk-informed category for a plant state is given by:

$$\Phi = \sum_{n=1}^{NP} \sum_{i \in R_n}^{I} F(D_i^{small}).$$

Plant ΔCDF - plant states

Example of two plant states; two or more trains in operation and; one train operation:

If f_2 is the success frequency for two or more trains operating and f_1 is the success frequency for single train operation, the total frequency, $\hat{\Phi}$, for both operating states:

$$w_j = \frac{f_j}{\sum_j f_j};\ j = 1, 2,$$

$$\Phi_j = w_j \sum_{n=1}^{NP} \sum_{i \in R_n}^{I} F(D_i^{small}),$$

$$\hat{\Phi} = \sum_j \Phi_j.$$

ΔCDF uncertainty analysis

ΔCDF was checked at all quantiles for Geometric aggregation and Arithmetic aggregation given in the NUREG 1829 tables. In addition, the frequency at DEGB-only for the same quantiles was assessed

Quantile	Case 1 GM	Case 1 AM	Case 2 GM	Case 2 AM	$\hat{\Phi}$ (GM)	$\hat{\Phi}$ (AM)
Continuum Break Model						
5^{th}	2.64E-10	6.47E-09	3.68E-09	2.36E-08	3.08E-10	6.69E-09
50^{th}	7.50E-09	1.68E-07	8.30E-08	4.92E-07	8.47E-09	1.72E-07
95^{th}	3.43E-07	4.79E-06	1.81E-06	1.24E-05	3.62E-07	*4.89E-06*
Mean	1.17E-07	1.56E-06	5.10E-07	3.93E-06	*1.22E-07*	*1.59E-06*
DEGB-Only Model						
5^{th}	9.83E-11	8.18E-09	1.14E-09	1.66E-08	1.12E-10	8.29E-09
50^{th}	2.86E-09	2.07E-07	2.64E-08	3.90E-07	3.16E-09	2.09E-07
95^{th}	1.47E-07	7.06E-06	6.85E-07	1.21E-05	1.54E-07	*7.13E-06*
Mean	5.12E-08	2.06E-06	2.03E-07	3.61E-06	*5.32E-08*	*2.08E-06*

Plant $\Delta LERF$ analysis (strainer)

1. The STP RCFCs are capable of maintaining containment cooling without dependency on ECCS
2. Independence of containment failure from the concerns raised in GSI-191 allow an accurate estimate of ΔLERF based on ΔCDF:

$$\Delta LERF = LERF_{MOR}\left(\frac{\Delta CDF}{CDF_{MOR}}\right)$$

   where values of CDF_{MOR} and $LERF_{MOR}$ are the average values obtained from the PRA model of record
3. IF $\Delta LERF$ is in Region III of RG 1.174, THEN the (strainer) risk related to $\Delta LERF$ is acceptable

Plant $\Delta LERF$ analysis results

The ΔLERF values for the geometric mean model for both continuum break and DEGB-only assessments are substantially below 1E-07. However, the values for the arithmetic mean are higher as expected due to the very high estimates that result from the arithmetic mean aggregation in NUREG-1829.

Model	ΔLERF using $\hat{\Phi}$ (GM)	ΔLERF using $\hat{\Phi}$ (AM)
Continuum break model	*7.67E-09*	9.99E-08
DEGB-only model	*3.34E-09*	*1.31E-07*

In-vessel analysis

1. The risk due to core loading effects needs to be assessed against strainer penetration test data
   - Cooling effectiveness for fiber blockage
   - Boron precipitation for blockage from the lower plenum
2. Thermal-hydraulic analysis for adequate cooling for all hot-leg breaks and small cold leg breaks under bounding blockage scenarios
3. At the amount of the fiber assumed in the strainer test, the amount that penetrates the strainer and arrives in-vessel is less than 15 gm/FA (WCAP-16793)

RoverD analysis results

1. There are 45 locations (welds) in the risk-informed category and with the exception of one, all are in the RCS loop piping
2. The maximum frequency (smallest break size that exceeds the tested amount of fiber) is a DEGB of the 16 inch surge line
3. In-vessel fiber loading is not exceeded for any scenarios equal to, or less than, the tested fiber amount using bounds of the data measurements
4. All welds that exceed the tested amount of fiber have been either mitigated or replaced
5. All results using quantiles from NUREG 1829 geometric mean aggregation, both the RoverD continuum break model or DEGB-only break model ΔCDF are less than 1E-06 (RG 1.174 Region III)
6. Using quantiles from NUREG 1829 arithmetic aggregation, the mean and 95^{th} quantiles exceed 1E-06 (RG 1.174 Region II)

Regulatory Implementation

- Exemptions required for LOCAs that can generate debris that is not bounded by plant-specific testing
- Exemption would permit use of risk-informed approach instead of prescribed deterministic methodology
  - 10CFR50.46(d) ECCS "other requirements"
  - GDC 35 ECCS
  - GDC 38 Containment Heat Removal
  - GDC 41 Containment Cleanup
- Exemptions apply only for the effects of debris

Regulatory Implementation

- Amendment to the license
  - Risk-informed approach is a methodology change per 10CFR50.59
  - STP is proposing new actions to be added to the ECCS and the Containment Spray TS

Reactor Containment Building emergency sump shall be OPERABLE by limiting the containment debris quantities to be less than or equal to the STP debris analysis assumptions.

With less than the required [ECCS or Containment Spray] Systems OPERABLE due to potential effects of debris, perform the following:

a. immediately initiate action to implement compensatory actions,

and

b. within [90 days] restore the affected system(s) to OPERABLE status,

OR

Be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours,

Regulatory Implementation

- UFSAR changes
  - Ch. 3 GDC description
  - Ch. 6 Engineered Safety Features
- Technical Specification Bases
  - ECCS
  - CSS

Conclusions

- The RoverD process incorporates all aspects of the debris issue
  - Debris generation and transport
  - In-core effects
  - Deterministic (testing for fiber and chemical effects)
  - Risk-informed evaluation
- RoverD demonstrates very small risk per RG 1.174

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

STP Deterministic Strainer Testing

ACRS T/H and Risk-Informed Subcommittees March 18, 2015

Steve Smith
Office of Nuclear Reactor Regulation

STP Background

- High Fiber Plant
  - Nukon and Thermal Wrap
  - Little other insulation material
  - Very small amount of microporous insulation (Microtherm)
- PCI Uniform Flow Strainer
  - 3 trains of ECCS each with its own strainer
  - 2 trains required for operability
  - 1818.5 ft^2 strainer area per train
  - 0.0086 ft/sec strainer face approach velocity
- STP GL 2004-02 deterministic submittal at ML083520326
  - Discusses strainer testing and other GL 2004-02 areas

Test Assumptions and Application

- Test geometry
- Debris generation/surrogates
  - Debris sizing/characteristics
- Transport/debris amounts
  - Limiting debris load (including thin bed and full debris load)
  - Debris addition sequence
- Maximum flow velocity
- Submergence/vortexing/flashing
- Chemical effects (WCAP 16530-NP-A method)
- Termination criteria
- Viscosity correction

STP Test Methods

- Testing per NRC staff guidance (ML080230038)
  - Allowed near field settling
    - Staff conducted significant discussions with PCI regarding credit for near field settling in testing
    - Added controls on debris preparation, addition methods, and addition sequence
    - Significant evaluation of flow and turbulence fields
    - Staff evaluated debris that settled in the flume
  - Other PCI test methods similar to other vendor testing
  - Test module was 91.44 ft^2 (about 2.5% of two trains)
  - 100% of debris predicted to transport included in test

STP Head Loss Test Key Results

- NRC staff observed two tests in 2008
- 2008 trip reports are available:
  - February – ML080920398
  - July – ML083470317
- February test resulted in excessive head loss before chemicals were added to the test
- July test resulted in acceptable head loss
  - Maximum head loss about 9 ft (at 110-120 ^{o}F) including chemicals

STP Test Observations

- February 2008 Test Observations
  – Test with only fine fiber and particulate resulted in very high head loss
  – Test that allow debris to transport to strainer without agitation result in very high head losses if enough fine fiber transports

STP Test Observations

- July 2008 Test
  - Differences from February Test
    - Non-zinc coatings were represented by actual paint instead of walnut shell flour
    - Some coatings were added as chips
    - Fibrous debris reduced (7D vs 17D ZOI, about 14x volume difference)
    - Marinite powder used instead of cal-sil
  - Conclusions
    - Lower head loss due to reduction in fibrous debris
    - Other test surrogates may have had some effect
    - First batches of chemical precipitate had a large effect

STP Head Loss Testing Summary

- February 2008 Test
  - Test included debris based on staff approved ZOIs
  - STP determined that debris amount must be reduced to achieve acceptable head loss results
- July 2008 Test
  - Repeat of February test with reduced fibrous debris amount
    - Based on a 7D ZOI vs. staff approved 17D ZOI
    - 7D ZOI jet tests were subsequently not accepted by the staff
    - Therefore the July test fiber quantity was not considered bounding for the STP plant condition
  - Test was conducted with accepted methods and assumptions
    - Debris preparation and introduction met staff guidance
    - <u>Can be used to establish a debris limit for STP</u>

The End

- Questions
- Discussion