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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE

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OPEN SESSION

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MONDAY

SEPTEMBER 16, 2019

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B10, 11545 Rockville Pike, at 1:00 p.m., Joy Rempe, Chair, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chair

RONALD G. BALLINGER, Member

MICHAEL L. CORRADINI, Member

WALTER KIRCHNER, Member

JOSE MARCH-LEUBA, Member

HAROLD B. RAY, Member

PETER RICCARDELLA, Member*

MATTHEW SUNSERI, Member*

DESIGNATED FEDERAL OFFICIAL:

WEIDONG WANG

ALSO PRESENT:

STEVE BAJOREK, RES

JOSH BORROMEO, NRR

MIRELA GAVRILAS, NRR

PAUL KLEIN, NRR

JANE MARSHALL, NRR

SCOTT MOORE, Executive Director, ACRS

BENJAMIN PARKS, NRR*

DAVID RUDLAND, NRR

ASHLEY SMITH, NRR

STEVE SMITH, NRR

*Present via telephone

P R O C E E D I N G S

(1:07 p.m.)

CHAIR REMPE: This meeting will now come to order. This is a meeting of the Thermohydraulic Phenomenon Subcommittee of the Advisory Committee on Reactive Safeguards. I'm Joy Rempe, Chair of today's subcommittee meeting. Members in attendance are Mike Corradini, Ron Ballinger, and Harold Ray.

We also have Matt Sunseri and Pete Riccardella, who have joined us on the line, and we expect Walt Kirchner to arrive later during this meeting. Members Matt Sunseri and Pete Riccardella are connected using a public line, so they are on mute, but I will try hard to remember to periodically ask that that line be opened so they have an opportunity to ask questions.

Weidong Wang of the ACRS staff is the designated Federal official for this meeting. During today's meeting, the subcommittee will review a staff technical report, technical evaluation report of in-vessel debris effects. The subcommittee will hear presentations by and hold discussions with the NRC staff and other interested persons regarding this matter.

This subject was first reviewed in our

April 2019 subcommittee meeting, and this meeting is a follow-up for additional information. The rules for participation in all ACRS meetings, including today's, were announced in the Federal Register on June 13th, 2019.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, agendas, letter reports, and full transcripts of all our full and subcommittee meetings, including slides presented at such meetings. The meeting notice and agenda for this meeting were posted there, and we've received no written statements or requests to make an oral statement from the public.

Today's meeting is open to public attendance. If necessary, part of the meeting will be closed in order to discuss information that is proprietary, pursuant to 5 U.S.C. 552b(c)(4). Attendance at all portions of the meeting that deal with such information will be limited to the NRC staff and those individuals and organizations who have entered in to an appropriate confidentiality agreement.

Consequently, we'll need to confirm that we have only eligible observers and participants in the room for any closed portion of the meeting, if we decide to

close it. During this meeting, our subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee.

The rules for participation in today's meeting were included in the June 13th, 2019 notice published in the Federal Register, and a transcript of the meeting is being kept and will be made available, as stated in that Federal Register notice.

Therefore, we request that participants in this meeting use the microphones located throughout the room when addressing the subcommittee, and the participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard. And we'll now proceed with the meeting, and I'd like to start by calling upon the NRR staff.

MS. MARSHALL: Thank you, Chairman. Good morning. My name is Jane Marshall, I'm the acting director of the Division of Safety Systems, and we're here to present the final staff technical evaluation report on the safety significance of in-vessel downstream effects in operating PWRs.

As you noted, this is a follow-up to the April meeting where we presented the draft TER, and

the subcommittee asked staff to return when the TER was final, so that's our meeting here today. At that meeting in April, the subcommittee members also made some comments and asked questions about the TER, and we appreciate the feedback and will discuss the changes that we made to the TER in response to some of those questions today.

The staff does not expect a letter from ACRS on this TER. We also would like to note that this topic is an indication of the way that the staff is being asked to transform and use more risk-informed approaches to regulation. So it may seem a little bit different than some of the things we've done, historically. We appreciate your interest and your feedback on this issue.

CHAIR REMPE: And just to be clear, you've not asked for a letter on this, right? And you don't expect to have any sort of letter from us as you continue to go through and evaluate each plant's compliance --

MS. MARSHALL: Correct.

CHAIR REMPE: -- with it?

MS. MARSHALL: Correct.

CHAIR REMPE: Okay.

MS. MARSHALL: We do not expect.

CHAIR REMPE: Okay. Thank you.

MS. MARSHALL: Thanks.

MEMBER CORRADINI: Can I get something clear? In the executive summary, the final sentence is, the staff is evaluating compliance in an effort to separate from the TER. So, there is a slide in the slide packet, is that final figure the one piece of information on how compliance is to be met from a logic standpoint?

MS. MARSHALL: I think that's probably the only thing we have in there.

MEMBER CORRADINI: Okay. So we'll just wait until then?

MS. MARSHALL: The flow chart?

MEMBER CORRADINI: Yes.

MS. MARSHALL: Yes.

MEMBER CORRADINI: The yes/no diamonds?

MS. MARSHALL: Yes.

MEMBER CORRADINI: Okay.

MS. MARSHALL: That's right.

CHAIR REMPE: So since we're kind of going out of order and this is in the backup, I know you had a meeting with the PWR owners group recently. How are they receiving this guidance document and the information in the technical report? Do they think it

provides a good pathway?

MS. MARSHALL: It does, and they seemed very energized by it and very eager to move forward and close out the issue, and they're moving forward with this guidance. We've discussed it with them on a couple of occasions.

CHAIR REMPE: Okay, good.

MS. MARSHALL: Yes.

CHAIR REMPE: Thank you. Go ahead.

MR. SMITH: All right, so we'll get started. I'm Steve Smith, I'll be starting off the presentation. This is just basically an informational briefing. The other presenters are Ashley Smith and Paul Klein. We do have one important member of the team on the phone, Ben Parks. I just want to be sure, Ben, can you hear us?

MEMBER CORRADINI: He might be muted.

MR. SMITH: Oh, he's muted?

CHAIR REMPE: So he can't talk?

MR. SMITH: The public --

CHAIR REMPE: Why don't you go ahead and open it?

MR. MOORE: This is Scott Moore. The public line is muted right now, so nobody on the public line can respond.

CHAIR REMPE: Let's go ahead and open it and let him respond, just to make sure he's there and then also, I'll give Pete and Matt a chance to speak up. Okay?

MR. MOORE: Okay.

MR. SMITH: All right. Ben, can you speak to us?

MR. PARKS: This is Ben, I can hear you.

MR. SMITH: All right, good, we can hear you, too. Great. Thank you.

MR. RICCARDELLA: This is Pete. Why don't you check and see if anybody else besides Matt and Ben and I are on the public line, and if not, just leave it open?

CHAIR REMPE: Is anyone else on the public line, other than the three individuals?

MS. SMITH: It says there's nine. We're getting an indication there are nine.

CHAIR REMPE: There are nine people, so I think we are going to have to mute it, but we're going to try and open it periodically for you guys, okay?

MR. RICCARDELLA: All right, thanks.

CHAIR REMPE: Okay.

MR. SMITH: All right, thanks for the help with that. We also had input from other staff and

NRR, particularly the MLR, DSS, and DRA, and of course, research helped us out with the TRACE work that you heard about before, and also with some work in xLPR that we had talked about last time.

MEMBER CORRADINI: So let me ask the question here, and you don't have to answer here, but I'm looking -- I'm trying to understand the basis of the low safety significance finding. Is it the RES calculations that are sensitivities on the base? Is it using the Westinghouse submittal in appropriate engineering judgment calculations? What's the essence of the technical basis for the finding?

MR. SMITH: Do you want to?

MR. KLEIN: I would say the essence is all information compiled, including the WCAP that was submitted, independent research work, plus the combined experience and judgment of the staff that have been working the issue for, you know, 10 to 15 years.

MEMBER CORRADINI: Okay, but it's not the Westinghouse submittal, because you use some numbers from the submittal within a context, but as I see it, you're talking through a story. And once you talk through the story, you do some sensitivities, and given all of that, you feel good. So it's really the

judgment of the staff given the pieces?

MR. KLEIN: I believe so. I think the argument that we presented in April was that when you look at the combined evidence, we don't believe that you can block the core inlet, and although we didn't write a CT evaluation on the WCAP, itself, we felt very comfortable using that information as a defense in depth argument that should the staff judgment be wrong and you do block the core inlet, there are alternative flow paths that could provide sufficient cooling -- long-term cooling.

MEMBER CORRADINI: Thank you.

MR. SMITH: Specifically, I don't know if you're asking about the risk values, the order of magnitude values. Those are all calculated just based on break frequency and certain pipe break sizes.

MEMBER CORRADINI: I was going to get back to that, but I was trying to get a bigger picture about -- microphone, please? Sorry, excuse me, I apologize. I was trying to get a bigger picture of, is it the totality of everything, or if there are individual pieces you sit on. So it sounds like it's the totality of all the pieces with a judgment call from the staff?

MR. SMITH: Right. The risk value's

purely based on break frequency. Everything else is integrated decision making.

MEMBER CORRADINI: Okay.

MR. SMITH: Yes.

MEMBER CORRADINI: Thank you.

MR. SMITH: So we can move to slide two, and I just want to express our appreciation for our continued interactions on this, and the input you've given us, I think, has definitely improved our product, in this case and in other cases.

The TER, when we came to you, it seemed like there was a lot of lack of clarity. People didn't really understand it. So we revised it based on ACRS member and peer review comments to make it more readable, and to clarify its intent, and to clarify the information that was used and the extent of each information source that was used.

And also to try to clarify the logic used by the staff to reach the conclusions. We don't have a lot of time. I guess we might have more time than I thought we had, but we're not going to try to repeat too many of the details that we went through last time. And the first nine slides are just kind of background on what we talked about before.

And after that, we'll get into the changes

that were made as response to some of the questions, and peer review, and ACRS member comments that came up. And if you have any questions, it appears that you will feel free to ask them at any time.

MEMBER CORRADINI: I'm sorry, I'm just asking all sorts of starting questions. Is this going to be -- let me put it in a historical context. So when I first started, which was a while ago, this was talked about, literally the same topic. So I assume the commission has been briefed on this, or they will be briefed, so they understand the context of this?

The reason I'm asking the question such as that is, it's a story, and I'm still struggling in the current TER to see how the pieces of the story fit together, whether it be a graphic, a walk through. The closest thing is why I asked the question about slide 22, because in some sense, your thinking about compliance actually leads to some sort of logic thing.

MR. SMITH: Right.

MEMBER CORRADINI: So is this going to be presented to the commission, or does it stop at the NRR director?

MR. SMITH: From a high level, we brief the commission every six months, the commission TAs, on --

MEMBER CORRADINI: Okay.

MR. SMITH: -- our path forward, and in our last meeting, we did discuss with them what we're doing with the TER, and they're comfortable at a high level. Not in the amount of detail that we've gone into with you, but they were comfortable with what we did, and they didn't ask a lot of pointed questions at the time.

MEMBER CORRADINI: Okay, fine. Thank you.

MR. SMITH: All right. So we're going to move on to slide three. This is just a recap of what we talked about in April. In that meeting, we talked about actions that were taken by NRC and industry to address the effects of debris over the last several -- many years.

We provided discussion of our TER, and we took feedback from the ACRS members to help us make improvements with the TER. On slide four, the first bullet, we discussed this a little bit in April. The NRR goal is to align NRC and industry resources with the safety significance of issues.

The TER was an attempt to evaluate the overall safety significance of in-vessel downstream effects, and we took into account a lot of new knowledge that we've gained over the past couple of

years, and a lot of knowledge that's been around for quite a long time.

And the one thing that we think is important, and we'll have another slide on this, defense in depth is maintained even if the core inlet becomes blocked.

CHAIR REMPE: Just, again, to help me make sure I understand, TRACE doesn't ever predict blockage. You've just assumed blockage?

MR. SMITH: That's correct.

CHAIR REMPE: Okay.

MR. SMITH: TRACE assumed, you know, various amounts of blockage, starting at a relatively high amount, and then actually blocking the core and let off completely.

CHAIR REMPE: But that's a user defined input to do that?

MR. SMITH: Yes.

CHAIR REMPE: Okay.

MR. SMITH: Yes. I don't think it would be -- I don't think we have the modeling capabilities

CHAIR REMPE: That's what I thought, but I just wanted to make sure, because sometimes in the TER, I got a little confused. So thanks.

MR. SMITH: Yes. To predict how much

debris is going to go where in the core, and when it's going to block, you know, that would -- that's something that's probably beyond our ability.

CHAIR REMPE: That's what I thought. Thanks.

MR. SMITH: Okay. Slide five, this slide provides just a scope of what the TER evaluation was, and as Jane talked about, it was atypical for really, two reasons. Instead of using deterministic methods, which is what we're used to using when we talked about 5046, we used integrated decision making.

And we also divorced the consideration of compliance from the safety significance determination. And I think that the TER was confusing. It may still be confusing because of such a change in the way that we do things and the way we think about things. But since the TER came out, GSI-191, the GSI was closed, and there has been a lot of confusion, both inside and outside the NRC.

The GSI was closed basically because it was determined that the important technical issues associated with it were well enough understood that we didn't really need to study them anymore, and it fell out of the GSI program. The GSI program said, okay, you can exit, you can take this out of the GSI

program.

Some people think that because the GSI was closed that there's no further action needed on this issue, and that's not what the case is. There's 21 plants that have closed the issue. They don't have to take any more action. But the rest of the PWRs have to close the generic letter 0402 by providing specific responses to the NRC.

Actually, they don't have to, but that's what we've requested them to do, a generic letter. You know, we've just asked them to provide us information. They don't have to if they don't want to, but they're doing that. We're working to develop guidance, which we talked about a little bit earlier, on how they can respond to the in-vessel part.

The strainer part of the issue, nothing has changed. They still have to treat the strainers the same as they've always been treated in the past. We have existing guidance that's been accepted for a long time, and that's what they're using to address the strainers. And then once these plants provide the information, then we'll close them out on a plant specific basis, one by one.

MEMBER CORRADINI: So let me ask about the second bullet. Is there a document or a process that

one follows for integrated decision making? In other words, if I go to Reg Guide XYZ, there is a process flow? Or is this a new thing within the staff to try this approach?

MR. SMITH: This is new. We did use a lot of guidance out of Reg Guide 1.174.

MEMBER CORRADINI: Okay.

MR. SMITH: That's kind of the way we thought about this, using defense in depth safety margins, thinking about those sort of things.

MEMBER CORRADINI: Because I'm not against it. I like the fact that you actually don't use numbers only, but you actually have judgment. I just was looking for some connection, because in section whatever it is, you go through a series of steps, and I'm trying to decide were those steps predetermined, or did you organize these thoughts because of this issue?

MR. SMITH: I guess we would have to see what you're talking about, but I think we're doing a lot of new kind of thinking when we did this.

MEMBER CORRADINI: Okay. Well, the reason I'm saying that is not that I disagree with it, more the fact that it would be good to then document the fact that you've developed a process of thinking about

this that might be useable in other venues, where something has, pardon the word, lingered, and --

MR. SMITH: We did think about that, and I think that we and higher levels of management understand that we need to get our processes caught up with the way we're trying to do things.

MEMBER CORRADINI: Okay.

MR. SMITH: And I think there's other people who are doing that at more generic of a level.

MEMBER CORRADINI: Thank you.

CHAIR REMPE: Okay. At this time, let's just stop for a second and get the line open. Thank you for the reminder. Is it open? Okay, can everyone but Pete and Matt put your phone on mute? And Pete or Matt, can you both chime in and say, do you have a question, and say what it is if you do?

MEMBER SUNSERI: This is Matt, I don't have any questions.

CHAIR REMPE: Thank you. Pete?

MEMBER RICCARDELLA: This is Pete. I don't have any questions, either.

CHAIR REMPE: Okay. Please, everybody, let's mute it again. Okay, go ahead.

MR. SMITH: All right, we're going to move along to slide six, and this is a slide that

highlights the primary reasons why the ECCS design flow path won't be blocked. So the core inlet's not going to become blocked at the following LOCA.

This was discussed in more detail in April, and I'll just go through. We think that the uniform bed formation is unlikely. There's very few breaks that generate enough debris to cause a core blockage. Long-term core cooling has been shown using TH analyses, long-term core cooling is maintained with a high level of blockage at the core inlet.

And then, we have some testing that shows that if you don't have chemical precipitants, you can incur a lot of fiber and particulate loading at the fuel inlets without blocking the core and still being able to get enough flow through. And then there's other things that are done, like switch over for most of the plants.

Some of the plants, like the BNW plants, do a little bit different. BAT mitigation strategies, and those are -- those have been well established in there in all the plants' emergency operating procedures that would bypass that BAT that would -- could occur at the core inlet.

CHAIR REMPE: When I was reading this, I was wondering, what are you going to do for the plants

that are putting in chromium coated, accident tolerant fuel or other types of accident tolerant fuel with coatings that may not be qualified from testing previously?

MR. SMITH: Right. So we didn't do anything about that. I think that a plant who does something like that would have to evaluate it using the 5059 process when they do install those kind of fuel assemblies in the core.

CHAIR REMPE: But not for a lead test assembly, I guess, because that's already being approved? So it'll be when they try to do a core loading, that will need to be documented that they need to consider this somewhere?

And it would be in -- what's going on with the accident tolerant fuel people, the staff, not you guys with this -- it would fall under the statement about unqualified coatings and you look for --

MR. KLEIN: Well, ultimately, the plant's responsible, if they make a change in the plant, to evaluate the potential impact. So I think they will have programs that are designed to consider blockages, a strainer blockage of the core inlet, and any change to the plant, our expectation would be that it's evaluated in terms of those two issues.

CHAIR REMPE: Okay.

MS. MARSHALL: If I may, Chairman, this is Jane Marshall, that phenomenon was considered in the first panel, the coating, and what would happen with the coating. And for the lead test assemblies, given the small number of lead test assemblies, there's not that much material.

CHAIR REMPE: So it'll come in when you start doing the core loading? Okay.

MS. MARSHALL: Yes. And that was considered, and it has been valid.

CHAIR REMPE: Okay.

MEMBER CORRADINI: But there will be testing required by the proposers to show there's no flaking?

MR. SMITH: Right.

MS. MARSHALL: Right, and adhesion is one of the phenomenon, yes --

MEMBER CORRADINI: Okay.

MS. MARSHALL: -- and they are testing.

MEMBER CORRADINI: Thank you.

MR. SMITH: All right, on slide seven, this is a slide that we saw in April, but we thought it was an important concept, and we feel that the defense in depth that is available is significant for

this issue.

On the left side in the red, when you hit the red left side of the thing there, that means that our assumption that the core is not going to become blocked is wrong, okay? So from thereon out, we need defense in depth. We didn't credit the alternate flow paths from the WCAP in our evaluation of whether the core would become blocked or not, but we did believe that the alternate flow paths would provide a good means to get coolant into the core.

The next three columns are just operator actions that can be taken if the core inlet was to become blocked, and then the last column talks about containment integrity. The strainer evaluation is separate from the in-vessel evaluation and the deterministic strainer evaluations, and the staff's opinion show that the strainers will function under all design basis accident conditions.

So we expect that they would still function to allow containment spray to function, and you would still have your containment function -- your containment cooling function intact. And this is the end of my presentation. Ashley's going to take over with the next slide.

MS. MARSHALL: Chairman, that might be a

good point.

CHAIR REMPE: Okay. Actually, before I open up the line, or while you're opening up the line, didn't you used to have this defense in -- my notes indicated you used to have this defense in depth discussion in the executive summary, but in the most recent version, I didn't find it. Is there a reason that that was -- or did I just miss it, my notes aren't correct?

MR. SMITH: We did change the executive summary quite a bit, and I don't remember the reason that we would've taken defense in depth out of there.

CHAIR REMPE: Okay. I just was curious. Anyways, I think the lines are open. Pete, Matt, do you have any questions?

MR. RICCARDELLA: No questions here. This is Pete.

CHAIR REMPE: Not hearing anything from Matt, we'll close the line and move on here. Okay?

MEMBER CORRADINI: So, let me ask a couple questions at this point, before we go to the TRACE analysis.

CHAIR REMPE: Thank you. Go ahead.

MEMBER CORRADINI: Okay. So here's where I'm looking for some sort of story board that takes me

through the physical events with some sort of timing, and you don't have to do it, but if I were not embedded in this for a dozen years, I don't think I'd follow this stuff.

So, that's why I go back to the final slide. The way you talk through this picture, it's fine, but I think you've got to have something that actually talks through the accident. You've got three different -- approximately three different plant configurations, cold leg, hot leg, and then UPI, and then you've got different plans on how they might quantitatively change.

This strikes me that you want to go through that in some sort of fashion, otherwise, I would not understand if I was somebody that -- let me put it in a different way. If I didn't believe that the staff had thought this through, I'd challenge this until I saw some sort of logical talking through the points that, on a conservative basis, you still are okay, because as you said here, if the core is blocked, because I have a series of steps that occur, I then have alternative defenses.

But I still don't see that initial talking through, relative be to the time to block, the time to switch -- or, sorry the time for switchover, the time

for blockage, the time for, then I want to call hot leg switchover, the time for chemical precipitation, which in some sense, you have assumed times that are on the early end of each of those to give you margin.

And yet, I kind of have to still dig. It seems like a picture, a talking picture along with this sort of story board would be very helpful to the general public understanding the reason why you have so much margin. Because I think there is margin, it's just hard to extract it from the TER.

MR. SMITH: I can understand that. I think maybe the people who worked on it have been working on it so long, it maybe is more apparent to us what we were doing.

MEMBER CORRADINI: I'm kind of surprised the commission staff doesn't ask you to explain it in simple form.

MR. SMITH: I guess we could consider doing that. I guess we'll have to talk about --

MEMBER CORRADINI: All right, and I'm not trying to add work to what you have. If everybody understands it within the staff, that's fine, but I'm thinking about not the staff, but the general public understanding the decision relative to the reasons that there is significant margin at each stage of the

process. If you see where I'm going with this.

MR. SMITH: Yes, I think in the last meeting we did go through the scenarios for the various types of plants, but probably didn't explain, you know, in detail how the margins apply to each one of those --

MEMBER CORRADINI: Okay.

MR. SMITH: -- types of plants.

MEMBER CORRADINI: Okay, fine.

MR. KLEIN: I think one of the biggest things, and maybe we didn't communicate it well in the TER, but it's clear that the first WCAP owners group program that just assumed precipitate for them, and then they tried to use bounding parameters in order to run the tests.

When they went to the WCAP 17788 and did the actual tests in the enclave and followed the time dependent temperature profiles, it became clear from the results that chemical effects for, except maybe one or two plants, would come well after the point where a bed would get disrupted at the core inlet.

And I think that was one of the big changes in the owners group program that we saw, and it gave us confidence that -- but it sounds like we could've communicated that whole timeline better in

the TER.

MEMBER CORRADINI: Okay, thank you.

MS. SMITH: Okay, we're on slide eight, for those following along. So various sensitivity studies were completed by the Office of Regulatory Research to support the conclusions in our TER. Some were completed prior to the TER effort, and some were to support the TER effort, and we presented specific details of all those analyses in our April meeting.

Overall, we wanted to highlight a couple of the conclusions we had that boric acid precipitation was not found to inhibit long-term core cooling, and ultimate flow paths are a viable option to maintain long-term cooling -- long-term core cooling for both cold and hot leg breaks.

CHAIR REMPE: So during our discussion at the prior meeting, there was a table given to us where you had comments from industry as well as the staff, and the staff apparently had some concerns about the applicability of TRACE for these analyses. And I know you've modified the TER to talk more about the applicability of TRACE, but I guess it wasn't obvious to me still, what were the models this particular staffer or staffers were concerned about, and how did you address it?

Because again, I asked the question at the prior meeting, it was like, well, this came from the staff and we're addressing it, but I wasn't sure what the concern was and where the staffer was concerned about it.

MS. SMITH: What I remember is the concern was how we were relying more on TRACE than maybe the industry was, and we made it more clear in the TER that we were using TRACE to support our conclusions and not necessarily saying TRACE shows the conclusion.

CHAIR REMPE: Okay, so they didn't have concerns about the models just not being applicable for particular phenomenon? Because that's kind of how the comment read, and so --

MS. SMITH: That wasn't my understanding.

CHAIR REMPE: -- okay, so maybe I misunderstood what was written in the table. Okay, thank you.

MEMBER CORRADINI: Let me ask the question, maybe you're going to get to it later. So, how was the TRACE scenario developed so that -- is it a best estimate? Is it a bounding? Or is it just something to look at? Because there are certain timings it's assumed relative to switchover, to ramping up to complete blockage, to where the blockage

is, to et cetera, et cetera, et cetera. So how does one characterize the TRACE calculation?

MS. SMITH: We had the idea to do the TRACE calculation as a sensitivity study, so we tried to use a lot of the same inputs that we had from industry codes. I don't know if Steve wanted to chime in on any of that, but that -- we had the same inputs as far as timing, some switchover, the things that you had mentioned, so that we could show that our results were -- we could compare to what the industry had.

MR. BAJOREK: This is Steve Bajorek, Office of Research. I characterize the TRACE calculations as being more bounding. One of the first things we did, I think in consultation with the owners group, is we picked out a plant class that we thought would be conservative with respect to the alternate flow paths.

We picked the Westinghouse plant that had originally been down-flow converted to up-flow, so you didn't have communication from the barrel baffle region to the core. This would be something that would tend to starve the core. We picked areas, flow areas, and these are something that you can change in a user-defined function.

That gave us a way of bounding the K over

A squared, the net resistance to the bottom of the core, in order to be more conservative than what we thought industry should be. Now, for decay heat, we were -- best estimate, we used 79 decay heat, but we also did sensitivities to go back to a 73 decay heat to show what would happen if we were to add more power in the reactor.

And actually, with respect to boric acid precipitation, the higher power actually helps you. It increases the entrainment and helps you to, you know, flush out the core for a longer period of time. But other than that, these calculations were well on the conservative time.

And when we started this, I think that the time at which we initiated blockage of the core was conservative with respect to what we thought it was going to be. The ramp up time about consistent with what it would.

CHAIR REMPE: So I want to understand what you said. First of all, this entrainment phenomena with the decay heat effects, is that validated anywhere, or is it just, oh, this is common sense, but you didn't notice it until you saw it in TRACE?

MR. BAJOREK: Well, no, I mean, TRACE has been validated for large and small break, and at

entrainment carryover, very important for us.

CHAIR REMPE: Okay.

MR. BAJOREK: Okay, so we've used tests like FLECHT, FLECHT-SEASET, RBHT, in order to show that our entrainment models are approximately correct for carrying over, and --

CHAIR REMPE: But it's not the boric acid, per se, it's just the --

MR. BAJOREK: I'm not aware of any test where you --

CHAIR REMPE: Right.

MR. BAJOREK: -- orated things to try to do that, but one of the things that we did before we did the TRACE calculations is, we updated our thermophysical properties so that when you got high concentrations of boric acid, it was appropriately reflected in the fluid density, which can increase about 10 percent greater than pure water. And the viscosity, which is approximately 30 percent greater once you get to the precipitation of it.

CHAIR REMPE: Okay.

MEMBER CORRADINI: Let me just make sure I understand. So I'm not sure I should mention numbers, but there's a number assumed in the TRACE calculation for switchover from clean water to recirc

out of the sum. Then, there's another ramp up time from the K-loss being normal to the K-loss being essentially infinite over some other time window.

How are those determined? Because I don't know how one gets those numbers, so I'm trying to understand -- I mean, they might be conservative, I'm just trying to understand where'd they come from?

MR. SMITH: I think the time at which the resistance started ramping up was around 20 minutes, which is when most plants would -- that's the earliest time for most plants to switch over. So that's the conservative time, and then the value used, I think it was -- I forget how many seconds it was to ramp from --

MEMBER CORRADINI: I'm not sure I can say it, but it was --

MR. SMITH: -- zero to --

MEMBER CORRADINI: -- longer.

MR. SMITH: -- you can say that. So that was just something that we thought was a reasonable time to get the debris out of the pool and either collect it on the strainer or in the --

MR. BAJOREK: This is Steve Bajorek again. We did vary that. We looked at what we thought would be a best estimate time for the ramp up, and we also

did calculations where we made it much, much shorter than what it was going to be, and it didn't really affect things that much.

MEMBER CORRADINI: Okay.

MR. BAJOREK: We also looked at the hot leg switchover time. I went to the extreme, and he said what happens if it doesn't occur, ran the calculations out for I think it was something like 36 hours that basically showed that by the time you -- your real concern is keeping the core covered, okay?

By the time you precipitate, you would be uncovering the core. That would be more of your concern. So even within the absence of hot leg switchover, you have lots of time and lots of time relative to typical assumptions from when hot leg switchover's going to occur.

MEMBER CORRADINI: Okay. And then to kind of get back to Joy's question, TRACE can track concentration of boron in the water, and that's about as far as it goes. You essentially then look, if you get close to the precipitation point, but you don't model precipitation, nor do you model the debris.

MR. BAJOREK: We don't model the debris, okay? When you get to the precipitation limit, TRACE will take the excess boric acid and play it out on a

structure.

MEMBER CORRADINI: Okay.

MR. BAJOREK: And we saw that in the calculations when you dried out -- like, in the upper head, TRACE would say, hey, you're going to deposit a film of boric acid. Now, if you recovered that region with water, it would just go back into solution.

So as you get up to precipitation, TRACE is not getting the dynamics correct, at that point. It's just telling you that hey, this is the point in time when precipitation is likely to occur.

MEMBER CORRADINI: Okay. So I have a couple more questions. So you arbitrarily increase the K-loss such that it looks like it was blocking, and then at something like -- and I can't remember, in the document somewhere, it's something around, as I think one of the slides said, 99 percent -- you're still okay.

Is there a physical reason why it doesn't go to 100 percent? Because there used to be a member here that always believed it would go to 100 percent like a felt hat (phonetic).

MR. BAJOREK: Well --

MEMBER CORRADINI: You know what I'm getting at.

MR. BAJOREK: -- some sensitivities, that was just a sensitivity that was done. Actually, some increased the blockage to 100 percent. I don't remember that --

MEMBER CORRADINI: But then you have to rely on alternative flow paths?

MR. BAJOREK: That's right.

MEMBER CORRADINI: Okay. What I guess I'm getting at is, so that was your -- that was how you essentially evaluated margin was essentially take it as a series of parametric steps, then assume 100 percent, and then show that alternative flow paths would provide you enough?

MR. BAJOREK: That's correct.

MEMBER CORRADINI: Okay. And the reason the alternative flow paths don't clog?

MR. BAJOREK: Because they're too large.

MEMBER CORRADINI: So are we allowed to say what's large and what's not large? Is there a boundary between large and not large?

MR. BAJOREK: The --

MEMBER CORRADINI: We can go to closed session, if you want.

MR. BAJOREK: Yes, I don't know if we can say this on --

MEMBER CORRADINI: That's fine.

CHAIR REMPE: Okay.

MEMBER CORRADINI: That's fine. That's fine.

MS. SMITH: It's based on testing.

MR. BAJOREK: It's based on testing.

MEMBER CORRADINI: So it's actually -- there was testing where there was -- there were certain gaps --

MR. BAJOREK: Yes.

MEMBER CORRADINI: -- and then as the gaps grew, there was no way to block them?

MR. BAJOREK: Right, and as we reviewed -- as we did a review of the WCAP, we actually came back and said, hey, we don't think you should be crediting some of these, and they took them out of the calculations.

MEMBER CORRADINI: I see. Okay.

MS. SMITH: We asked do you have testing to show this opening size would be a viable option for debris to pass through? And they said we don't have testing to sort of show that, so we'll take it out, and they revised their conclusions.

MEMBER CORRADINI: Okay.

MR. KLEIN: I think another point to

mention, too, is that the amount of fiber per time continues to decrease dramatically. So as you get to a point where the core inlet may become more blocked, you also have a strainer that's being covered and allowing much less fiber to pass through it.

MEMBER CORRADINI: Okay. Okay, thank you.

MS. SMITH: All right, and then next, on slide nine, this is just a reminder from our April meeting that the staff conclusion in the TER is that in-vessel downstream effects are of low safety significance, based on our current state -- based on our current knowledge state.

All right, next slide. All right, so this is really the new information that we're presenting the next few slides. They're items that we wanted to highlight based on comments from ACRS members at the April meeting, as well as peer review and Peter Barrano's (phonetic) comments. The first item here is the definition of safety significance criteria.

We added this chart that's from the side into the TER as a revision based on ACRS member comments. Instead of using risk values from just Reg Guide 1.174 and new Reg 0058, we looked at a variety of NRC programs to ensure the definition of risk we were using to define safety significance within the

bounds of our available guidance.

And you can see as indicated at the arrow at the bottom, the staff determined the order of magnitude of the occurrence frequency that can challenge on control flowing would be 1 times 10 to the -6 per year or less.

MEMBER CORRADINI: So help me out. I know the last one, since one of our members has been educating us about 0058, and I know the first one. What are the two in the middle?

MR. SMITH: The significance determination process, that's something the region gets into more when they --

MEMBER CORRADINI: So this is at the region level?

MR. SMITH: -- they look back at scenarios that occurred at a plant, and they do a PRA, and they use that. And then the other one is LIC-504, which that's a -- one of the management directives that we use to -- or one of the procedures we use to evaluate this and similar kinds of occurrences.

MEMBER CORRADINI: So the blue arrow is supposed to tell me what?

MS. SMITH: That's just where we ended our evaluation. It's just a --

MR. SMITH: That's the order of magnitude or break frequency that we estimated would be -- could cause adequate fiber to be generated to block the core inlet.

MEMBER CORRADINI: And that corresponds to the pipe size that you use in the table one --

MR. SMITH: Yes.

MEMBER CORRADINI: -- as a break point?

MR. SMITH: Yes.

MEMBER CORRADINI: Okay. All right, I understand now. Thank you.

MS. SMITH: All right, next slide.

MEMBER CORRADINI: Do you want to ask the folks out in the -- I'm assuming that Dr. Riccardella cares about break size, so this might be a good chance to see if he cares.

CHAIR REMPE: Can we open the line?

MEMBER CORRADINI: Because I don't know break size -- yes.

CHAIR REMPE: Do you have any questions --

MEMBER RICCARDELLA: This is Pete --

CHAIR REMPE: -- do you have any questions, Pete?

MEMBER RICCARDELLA: I do. Can you hear me?

CHAIR REMPE: Yes, we can.

MEMBER RICCARDELLA: Okay. So the blue arrow, what break size are we talking about for that blue arrow?

MR. KLEIN: All right, so the blue arrow, it's not just for a single break size. It's for a hot leg break, and the actual break size that we evaluated was for a six-inch pipe, so it's a 5.19 inch break, and that's for a hot leg break. And then the cold leg break, we assumed anything smaller than 12 inches would not generate adequate debris to cause a blockage of the core inlet.

MEMBER RICCARDELLA: So anything smaller than what?

MR. KLEIN: A 12-inch break.

MEMBER RICCARDELLA: Okay. And, you know, another question I have is, the metric isn't actually RISP or CDF, it's Delta CDF. Would you explain that, please?

MR. KLEIN: Yes, so the Delta CDF, basically, we assume that if the break occurred, it's sort of a conditional --

MEMBER RICCARDELLA: Yes.

MR. KLEIN: -- we assume that if that break occurs, that you would go to core damage. So

the Delta CDF is between a plant that could generate enough debris at that size break, so a plant that would have no potential debris effects.

MEMBER RICCARDELLA: No debris at all, okay.

MR. KLEIN: Yes.

MEMBER RICCARDELLA: Okay. Got it. Thank you. I'll be interested, Joy, in talking later when we get into discussion of the risk analysis and later slides.

CHAIR REMPE: Is this the xLPR slide, or is it --

MEMBER RICCARDELLA: Yes.

CHAIR REMPE: -- okay. I'll try and remember. And then Matt, do you have any questions?

MEMBER SUNSERI: I don't, but can you hear me?

CHAIR REMPE: Yes, we can. Thank you.

MEMBER SUNSERI: Okay, thanks.

CHAIR REMPE: Go ahead.

MS. SMITH: Okay, we'll go to slide 11. We already talked about this a little bit, but we had comments about how TRACE was used to inform conclusions in our TER. Edits were made in the document like Joy had mentioned to clearly state what

TRACE is used for in the model. We're confident that the results support our conclusions.

We also had details of the various sensitivity studies added in a table. That was the same table that we presented to ACRS in April, and that showed the purpose of each study and more descriptive things about each study. Okay, I'm going to turn it over to Steve to talk about another thing we wanted to highlight.

MR. SMITH: Okay, so one of the ACRS members, or maybe more than one, requested that we do a sensitivity on the fuel assembly fiber amount that could be accommodated. They said, well, suppose you couldn't use the WCAP 17788 numbers, which shall not be named, and you used the 15 gram per fuel assembly value from WCAP 16793, which is what we know is conservative, and that included chemicals and all that.

So, we went back and looked at the data that we had from a high fiber plant in South Texas, and we didn't really have enough data on how much debris is generated from these break sizes. There was the four-inch breaks, there was only one break that generated enough debris to cause the 15 gram per fuel assembly value to be exceeded.

So there was actually one four-inch break that -- four-inch pipe break which would be a little bit smaller, 3 point -- I forget what the 3 point -- what the wall thickness is there. So there was one -- and the majority of the debris for those breaks comes from latent debris. So latent debris kind of dominates the term at these really low fiber levels.

Anyway, what we did instead -- so we looked at it that way, and then we looked at it from another perspective is that if the fiber penetration value, we used a -- the most conservative for our initial. We had a few sets of fiber penetration data that we could use.

If we used the most conservative value, 15 percent, and we did exceed the 15 gram per fuel assembly limit, and if we used the second most conservative value from the fiber penetration testing, which was 12 percent at that particular amount of debris, it would be below -- you would end up below the 15 grams per fuel assembly, even with the 6-inch break.

So that's the couple different ways we looked at it. We really didn't have enough data to do a good sensitivity study on exactly what pipe size you would have to reduce to. So we couldn't really

calculate a frequency. It's probably confusing.

MEMBER CORRADINI: Well, I was going to ask you if you could repeat some of that, because I don't get it. So what you did was to vary the pipe size, and then with a particular plant, look at what the fiber generation would be and then what was captured on the sum screens versus what's passed through?

MR. SMITH: That's correct.

MEMBER CORRADINI: Am I understanding this correctly?

MR. SMITH: That's correct, and we only had information from one plant, that was South Texas.

MEMBER CORRADINI: Right, because the RoverD analysis that they did.

MR. SMITH: Yes.

MEMBER CORRADINI: But their approach to this -- I'm not sure if we can say it. Their general approach to it -- let me try it that way -- their general approach to it was alternative flow paths after a certain point, if I remember correctly. That is, their RoverD approach to a deterministic in-vessel debris evaluation was essentially alternative flow paths got them past the point of concern.

MR. SMITH: They did a thermohydraulic

analysis, you're correct.

MEMBER CORRADINI: Okay. Okay. So --

MR. SMITH: They assumed that the core inlet was blocked at a very early time.

MEMBER CORRADINI: Much earlier than --

MR. SMITH: Yes.

MEMBER CORRADINI: Okay. Okay. All right, I think -- I don't remember who made this comment, but I'm just trying to understand what you did. Okay, so South Texas was, in some sense, a calculational example?

MR. SMITH: That was the only place that we had --

MEMBER CORRADINI: Enough information?

MR. SMITH: -- fiber generated per break size, but they only did it for six-inch pipes and then four-inch pipes, and two, you know? So between six and four, we just didn't have enough data to come up with some sort of a frequency, you know, a meaningful frequency number.

MEMBER CORRADINI: Okay. All right, thank you. Okay.

MR. SMITH: Okay, we'll move on to slide 13 and xLPR a little bit more about pipe break frequency.

MR. KLEIN: All right, I'll take this one. So, during the April subcommittee meeting, we were asked if the staff could use xLPR and try to benchmark the new Reg 1829 break frequency that was assumed in the staff TER.

So we had several members of the NRC staff run the xLPR code investigate the effects of pipe size, degradation mechanisms, how things like mitigation of susceptible wells and leak detection would affect some of the numbers, and we have some preliminary results that suggest the local frequencies in 1829 are conservative, but we consider those preliminary.

And I think that the effort was useful in terms of the lessons learned with the xLPR code, as well. So there's additional studies that are in progress, and we can take questions. We have the right people in the audience to address detailed questions.

CHAIR REMPE: So before I open the line for Pete's detailed questions, what are you going to do with these sensitivity study results? I mean, the TER is done, you're issuing -- you've already issued guidance to the owners groups. What are you going to do with it?

MR. KLEIN: I don't think that xLPR results are going to affect the TER. Like you mentioned, it's already issued and on the street, we don't feel a need to modify it based on the xLPR work that's been done to date.

CHAIR REMPE: Okay. Is the line open? Pete? Okay.

MEMBER RICCARDELLA: This is Pete. Is there openly going to be a report, or white paper, or something prepared on this study?

MR. KLEIN: I'm going to ask Dave Rudland to maybe step up to the mic and address that.

MEMBER RICCARDELLA: That would be great. Hi, Dave, how are you doing?

MEMBER CORRADINI: So since you're doing it -- since Pete asked about this one, I was going to ask about the TRACE one, so we might as well just get it all out on the table.

MR. RUDLAND: Hey, this is Dave Rudland, Senior Technical Advisor for Materials and the Division Materials License Renewal. Pete, right now, I don't know. We don't really have any large plans. We're kind of continuing this study to look at both these effects and those questions that came out of the new scale DCD review, also. I'm going to be

presenting some of these results at our PFM workshop at the end of October.

MEMBER RICCARDELLA: Oh, okay.

MR. RUDLAND: And we'll probably put together some kind of report, but we haven't really discussed what that would be at this particular time.

MEMBER RICCARDELLA: Okay, I wasn't aware of that workshop. What's the date of that workshop?

MR. RUDLAND: It's the third week of October. October 21 to 23, I believe. I don't have my calendar with me.

MEMBER RICCARDELLA: Okay, a three-day workshop.

MR. RUDLAND: Yes, it's a three-day workshop, and held here in D.C.

MEMBER RICCARDELLA: At headquarters?

MR. RUDLAND: Yes, we're actually having it at an off-site location, but in Rockville.

CHAIR REMPE: You can make a trip back the third week of October, right Pete? It's a joke.

MEMBER RICCARDELLA: Yes, that's the week we don't have subcommittee.

CHAIR REMPE: That's right, but you can make the flight back. There was a question Matt had? Matt, you got interrupted, did you --

MEMBER SUNSERI: I have no questions, just still following along. Thanks.

CHAIR REMPE: Okay.

MEMBER RICCARDELLA: Okay, thank you.

MEMBER CORRADINI: So can we pick up the question about the TRACE sensitivities?

MS. SMITH: Yes, so the TRACE --

MEMBER CORRADINI: Is there going to be --

MS. SMITH: -- the TRACE sensitivities were done as part of a user need that we had for the boric acid precipitation studies, and then we just did follow on studies to help us support conclusions in the TER. Right now, there's no intention for a white paper, but the report given to NRR, I have opposite research for that user need I'm sure we could make available if you're interested.

MEMBER CORRADINI: Okay.

MR. SMITH: It actually ought to be one of the references in the paper.

MEMBER CORRADINI: There is a reference? Did I miss it? I apologize.

MR. SMITH: It should be there. If it's not, we probably messed up.

MEMBER CORRADINI: Okay. Well, to the extent that it's available, I'd be interested.

MR. SMITH: Okay.

MS. SMITH: Yes, we'll be sure to get it to you, and I know it's in references. I don't know offhand which number it is.

MEMBER CORRADINI: Well, I didn't look, so --

MS. SMITH: Yes, we'll find out.

MEMBER CORRADINI: -- to be honest, I didn't -- okay, thank you.

MS. SMITH: And provide it.

MR. SMITH: All right, we'll go to --

MEMBER RAY: Wait, I'm going to ask a question. Are these studies of LOCA frequencies used elsewhere, other than this work that we're talking about today?

MR. KLEIN: The new Reg 1829 studies?

MEMBER RAY: Well, I guess. I'm really talking about the reference to 1829, it says, are conservative. I'm asking about the results that we're talking about in this meeting, which are preliminary results as it's described there on the third bullet. Are they going to be used for anything else, other than what -- GSI-191 related?

MR. KLEIN: Well, I think there's more work that needs to be done, which is why we

characterized it as preliminary. So I think xLPR still may need a few tweaks in order to optimize it and the work that was done to do this evaluation is helping that effort.

So I don't think the end goal with the xLPR effort was really to have a grand result, but it's more to look at the 1829 assumptions and say, could the staff have erred on the LOCA frequencies? And the preliminary results suggest that that's not the case, that those frequencies are probably conservative.

MEMBER RAY: Well, I'm thinking about risk informing consideration of future plant designs, that sort of thing. And I'm just wondering if these -- if this work leads, ultimately, to some update or input basis, whatever you want to say, that we may be using and thinking about future plant designs.

MR. KLEIN: Dave, I'll defer to you for long-term plans on xLPR.

MR. RUDLAND: Yes, this is Dave Rudland again. The study we did was kind of focused here, right? Just to kind of give us a feel for the conservative nature of 1829, and in order to do the job correctly, to really confirm all of the results according to plan would be a much more expansive

effort. Now, I think it's a doable effort, but I just think right now, we don't have the plans to expand it all that far.

MEMBER RAY: Okay, well that really gets to my point, is that this isn't something that once done, it gets picked up and used elsewhere?

MR. RUDLAND: Yes, it would need to be expanded much further if it were going to be used generically.

MEMBER RAY: Thank you.

MEMBER RICCARDELLA: This is Pete, can you guys still hear me?

MR. RUDLAND: Yes.

CHAIR REMPE: Yes.

MEMBER RICCARDELLA: I'd like to, you know, at some point, I'd like to see almost a statement. I was one of the co-authors, or one of the experts on the new Reg 1829 extra panel, and I recall we had tables of break sizes with kind of ranges of frequencies for each size.

I just would like to see just from your preliminary results what those -- how the xLPR ranges compare. I mean, were they an order of magnitude? You said they were conservative. Were they an order of magnitude lower, a couple orders of magnitude?

MR. RUDLAND: So this is --

MEMBER RICCARDELLA: Did the uncertainty ranges overlap?

MR. RUDLAND: So this is Dave Rudland. Pete, again, we didn't do an exhaustive enough search to be able to really give ranges of uncertainty on the failure frequencies. What we did was we did a sampling of several different pipe sizes and degradation mechanisms, from select cases from 1829, just to look at that.

And again, you know, the numbers were based on our assumptions of crack initiation frequencies, and they turned out to be a couple of order of magnitude below those that were in 1829. And again, the details, I think, would be more -- the details of the analyses and the results would be more informative than just a table of frequencies.

MEMBER RICCARDELLA: Okay. And you said that workshop is the week of the 23rd?

MR. RUDLAND: What I'll do, Pete, is I'll take an action to send you the flier for the workshop.

MEMBER RICCARDELLA: Thank you, I appreciate that. That's all I have.

CHAIR REMPE: Okay, thank you. Go ahead.

MR. KLEIN: All right, move to slide 14.

Okay, I'll take this one, too. This is the final slide in our regular scheduled program here. So, the purpose of the TER, as we mentioned, was to evaluate the CET significance of in-vessel downstream effects.

Based on the current knowledge base and the TER, the NRC was able to close GSI-191, and Steve explained the difference between closure of GSI-191 and licensee resolution, which will be addressed separately as part of the generic letter process. I think we're really, at this point, ready to address any additional questions.

There's an ML number listed for the NRC staff review guidance, and that review guidance is intended to help the staff address licensee responses as they're submitted to the NRC staff. And we have tried to develop that guidance with both a number of internal NRC staff and also external stakeholders.

And most of the core team that worked on the TER was also involved in the staff guidance, and we have a schematic, if you'd like us to put that up and begin discussions on the staff guidance, if that would be helpful.

CHAIR REMPE: I would like to see it. This is slide 22, right? Have you discussed it? It's in the guidance, which is publically available, so

let's go for it.

MR. KLEIN: So, I'll start this, Steven, and maybe you, and Ashley, and Ben can jump in, but in terms of just the philosophy of how to do review guidance, I think the general staff philosophy was we wanted to try to design a flow chart that would allow the plant with the least challenges to work through the process and maybe get the NRC staff closure in the most direct manner.

So we tried to set it up so that those plants with the most favorable attributes were able to pursue one of the early passed resolution, maybe one, two, or path three, which path one would include the plants that were able to close out under a previous WCAP because the staff understands what that amount of fiber that it's just extremely difficult to block the core inlet, including chemical effects.

And then paths two and three were designed for plants that have very favorable attributes in terms of alternate flow paths, or alternate ways to get flow into the core. So we felt the plants that were of the BNW plant design or upper plenum injection plants, if they met the fiber limits that were within WCAP 17788, that would lead to a direct closure path for those type of plants.

MEMBER CORRADINI: So let's just, if we could, so take box one. So box one says, go find a spectrum of break sizes that by 1829 are of high enough frequency and show -- and therefore show that you're less than 15 grams. If your answer is yes, then you go to the right, if the answer's no, then you go down and ask the next question?

MR. KLEIN: I think box one was intended to be a deterministic path based on WCAP 16793. Since the staff already had a CT evaluation written independent of that --

MEMBER CORRADINI: The size of the hot leg break. The worst break.

MR. KLEIN: Yes, worst break.

MEMBER CORRADINI: Excuse me, I misunderstood. I assumed you already had started chopping it with size. No?

MR. KLEIN: No consideration of size under path one. It would be the bounding break, can you meet that amount, and that would be the path that -- what we had turned to option one plants had taken to reach closure.

MEMBER CORRADINI: Okay. I misunderstood.

MR. SMITH: So this is the reason why it becomes confusing, because for all of these, because

this is more of a compliance thing than a safety significance thing, these plants all have to evaluate the worst possible break for how much fiber can get to the core, including single failure and all that. So all these fiber amounts that are calculated in here are more of a compliance thing. 5046 says you've got to calculate the worst scenarios.

MEMBER CORRADINI: Well, you've lost me now. I thought I had you, but now --

MR. SMITH: Okay.

MEMBER CORRADINI: -- I'm --

MR. SMITH: Sorry.

MEMBER CORRADINI: -- I'm decoupling.

MR. SMITH: I should have not said anything.

MEMBER CORRADINI: You could've just nodded and just let me go on my merry confused way. So box one is the largest break, not the largest break given a frequency?

MR. SMITH: No, it's the largest break. It's not necessarily the largest, but the biggest debris -- the one that generates and transports the most debris to the core.

MEMBER CORRADINI: Okay. Okay. All right, so this is almost a filter before -- excuse the

word, but it's a filter before you go through everything we just discussed? I'm having trouble.

MS. SMITH: It's separate. I think you're getting confused because the TER had frequency evaluation in it. When we did the compliance added, that was kind of separate.

MEMBER CORRADINI: Well, I'm concerned about inconsistency if I go through a compliance set of logic, I'm going to find myself in trouble, even though by the TER, it's of low safety significance. That's what's confusing, so help me.

MR. SMITH: Right. The TER, we wrote to determine the safety significance of the issue. We determined the safety significance of the issue was low, especially if the plant showed that they met the key parameters in the -- that we considered when we looked at that.

So then, after that, that kind of guided us into how we would develop our staff review guidance. Since it's a low safety significance thing, how much detail do we really have to look at? And so this is where Paul said, you know, we have to look harder at some plants, but every plant has to consider not based on what their break frequency is, unless they come in and get an exemption and do a risk

informed evaluation like STP did. Every plant has to consider the largest amount of debris that could reach the core under 5046 rules, basically.

MEMBER CORRADINI: Okay, all right. Do you want to add to this?

MR. LEHNING: Yes, this is John Lehning from the NRR staff, too, and I just wanted to say, where the risk part comes in is potentially on the bottom, the lowermost yellow box there, the plant specific evaluation.

So that is still an option, but basically, the rest of this flowchart is based on the compliance part, and for some plants that are able to show compliance that way without an exemption, that may be the easiest thing.

But it's not to say that we're throwing away the TER. That may still be a part of the basis for some of the plants that may not be able to do it for the whole spectrum.

MEMBER CORRADINI: So can I say what you just said differently? That is, by compliance, you assume 5046 rules all the way through, and you get to the yellow box, and then you might be able to apply the risk significance to let them off the hook?

MR. LEHNING: Yes.

MEMBER CORRADINI: To put it bluntly.

MR. LEHNING: Yes. If they wanted to use a risk informed argument, they would have to come in with a LAR and an exemption.

MEMBER CORRADINI: Uh-huh, but they could reference the risk -- excuse me, they could reference the TER and that calculational logic to show they fit within that box? That's what I'm still trying to --

MR. LEHNING: They could use a similar kind of logic. I mean, it's a little bit more -- when you do a plant specific calculation, we determine an order of magnitude when we came up with that 10 to the -6, right? They would actually use their PRA, they would come up with plant specific, you know, delta CDF numbers --

MEMBER CORRADINI: Okay.

MR. LEHNING: -- based on, you know, whatever break size they chose to -- or whatever breaks they chose to put in the risk informed bucket.

MEMBER CORRADINI: Okay. Well, I thought I had it. Let me say it differently. You're saying that in some sense, the TER is a guide to how they might have to do it if they find themselves in the yellow box?

MR. LEHNING: It would certainly provide

things for them to look at.

MR. KLEIN: I think the TER also informs path four, because if you go through the first three paths and you hit the red box, then the question is, you know, do you do something to disrupt an inlet bed before chemical affects four?

And then if the answer is yes, then you go into more of a WCAP 17788 analysis. So you might be given more credit for that analysis and being within the -- all the key parameters of the staff TER in that block four, as well.

CHAIR REMPE: So the TER isn't just the yellow box, it's the -- how you created box four? Is that a true statement? Because the TER helps you confirm that those parameters could get you out of there? Or --

MS. SMITH: I don't know if Ben had some examples that helped the implementation when we talked with the group. In the plant specific evaluation box, he talks about how plants may be able to make a plant specific evaluation if they didn't meet boxes one, two, three, and four. So that's why I'm wondering if Ben has some insights that --

CHAIR REMPE: Okay.

MS. SMITH: -- may answer your question.

FEMALE: And you opened the bridge line?

CHAIR REMPE: I think it's open, because I hear noise, but Ben, are you there?

MR. PARKS: Yes, this is Ben Parks with the staff. Can you hear me?

CHAIR REMPE: Yes.

MR. PARKS: Okay. So this whole flowchart and the staff guidance document is all purely deterministic. There's no risk consideration here. In fact, I think we have a paragraph in the guidance document that says it can't align with these deterministic evaluations, you can't show that, you know, if you get a core inlet blockage, you're still okay, then you need to pursue a different approach.

And that's what Steve was talking about with the risk informed LAR and the exemption to the 1546 requirement. So if you get down to path four and you find that you don't meet the alternate flow path evaluations that were in WCAP 17788 plane four, then you need to do an evaluation to show, you know, that you have a lower core power level than might have been analyzed in 17788 for, you know -- you are much greater than 20 minutes when you stopover.

Basically kind of, like, one approach or one strategy there is you'd be chasing down and

showing that you have less decay heat than the industry's analyzed, and so a much less severe event than it may seem. And that way, you have assurance that even if you have a core inlet blockage, you don't have core damage follow it.

MEMBER CORRADINI: So let me say it back to you. We're following a deterministic set of questions, and I get to box four, and we haven't looked at 17788, it's too darn big. So therefore, there's something within 17788 that says the core fiber limit is above some set of numbers we don't need to discuss, and the switchover point is greater than 20 minutes. And what's RTP?

MS. SMITH: Rate of terminal power.

MR. SMITH: Rate of terminal power.

MEMBER CORRADINI: Oh, okay, thank you. Less than evaluated, and the flow resistance is by the other holes in the core are -- the resistance are less, you're okay, you go to the right, and you've essentially succeeded. If I don't and I go down to the yellow box on plant system evaluation, that tells you you're in a state of uncertainty, and the staff -- the licensee could use the TER as a roadmap to do a -- its own sort of plant specific evaluation?

MR. SMITH: That's correct.

MEMBER CORRADINI: So have I essentially said it about right?

MR. SMITH: That's correct, and the only time they --

MR. PARKS: Yes.

MR. SMITH: -- the only time they would get into any kind of a risk evaluation is if they couldn't show, you know, that actually, our thermopower is low, so, you know, we had an early switchover time. So we would actually be below the value that was calculated in the WCAP

MEMBER CORRADINI: Okay, fine.

MR. SMITH: They could use those to evaluate against each other, and if they couldn't do that, then they might get into the point where they have to come ask for an exemption and say, okay, certain breaks, we can't mitigate.

CHAIR REMPE: But you never proved the WCAP, but your evaluations that you did in support of the TER gave you confidence that the criteria in four were acceptable. So that's why I'm saying I thought that basically, you wouldn't even have box four if you hadn't have done all of this work for the TER. Is that a true statement?

MS. SMITH: We evaluated the top of the

report up to a certain point, and there were some areas that we felt was going to take a significant amount of time and effort to resolve, so we were given direction to go with this other path. So it's not that we never agreed with what was in the top report. We didn't finish our evaluation.

CHAIR REMPE: Right.

MS. SMITH: And this allowed us to show box four, okay, it sounds pretty good.

CHAIR REMPE: So if you had not done all this work for the TER, you could've made the conclusion for box four and said it was fine, it was just there were other things that you couldn't. So you didn't need all this, the trace calculations even do say those questions would let you go to a yes. I'm trying to understand and I'm asking both questions both ways to see what you say.

MS. SMITH: Yes, TRACE helps us support the conclusion that in box four, we think is okay.

CHAIR REMPE: So my first statement was correct? Granted, the TER will inform the yellow box, but the work you did for the TER also gave you confidence that box four was -- could be accepted and you could go directly to yes? So it did help you confirm the adequacy of box four?

MS. SMITH: Yes.

CHAIR REMPE: Okay.

MEMBER CORRADINI: Okay. So after all of that, now I am confused. Table two of the document we were supposed to read has a set of numbers, which we don't need to talk about what they are. Are those the numbers in box four?

MS. SMITH: The debris less than 17788 core inlet, yes.

MEMBER CORRADINI: Okay.

MS. SMITH: Yes.

MEMBER CORRADINI: But those were -- as I understand it, were calculated using a set of calculational procedures that was not exactly 17788? I thought there were -- my reading of the document was that you actually went through a set of what I'll call conservative assumptions that were not necessarily the same as 17788 to get those numbers. Am I wrong?

MR. SMITH: These numbers in that chart all came from 17788.

MEMBER CORRADINI: Oh, and that is what is being used as reference in the box four question?

MS. SMITH: Right.

MR. SMITH: Yes.

MEMBER CORRADINI: Got it. Okay.

MR. SMITH: These numbers assume, you know, a uniform debris bed at the core inlet and all that, so --

MEMBER CORRADINI: Yes, yes, yes.

MR. SMITH: -- that's why we think there's margin.

MEMBER CORRADINI: But that's what leads you to the next step about having to then evaluate the alternative flow paths with some empirical determined resistance or size that you must be below?

MR. SMITH: Right.

MEMBER CORRADINI: Or the resistance must be below, or the size must be above?

MR. SMITH: Yes.

MEMBER CORRADINI: Okay. All right. Got it. I think I got it.

CHAIR REMPE: So let's open up, I think the line's still open, but Pete or Matt, do you have any more questions?

MEMBER RICCARDELLA: This is Pete. I just had one. So do I understand you to say that if a licensee gets into the yellow box at the very bottom, that that requires a license amendment?

MR. SMITH: It may.

MR. KLEIN: Yes, not necessarily. It

would only do that if they couldn't evaluate the key parameters and show -- say there's some switchover really came at the earliest potential switchover actually came at 30 minutes, and their rated thermal power was lower than what was evaluated, they could show that their decay heat was below the value that was evaluated in the WCAP.

And that would be a relatively simple calculation, and in that case, you know, the plant specific evaluation would be relatively simple. Now, if they couldn't do that, and they had to say, okay, it's going to -- we have x number of breaks that won't get us below this core fiber limit, and we're going to have to take those out, then they would have to use a risk informed LAR.

MEMBER RICCARDELLA: Oh, I see, you have to take those out, or you just have to assume --

MR. KLEIN: Assume core --

MEMBER RICCARDELLA: -- so an overall risk informed -- or risk based approach would require a license amendment?

MR. KLEIN: Yes.

MEMBER CORRADINI: But an individual calculation to show on any one of the things that brought you down to the no question might be

calculable on a case by case basis?

MR. SMITH: Right.

MR. KLEIN: Correct.

MEMBER RICCARDELLA: So that would be effectively a yes to four then, really.

MR. SMITH: Yes.

MEMBER RICCARDELLA: In effect.

MR. SMITH: Yes.

MEMBER RICCARDELLA: Okay. Yes.

MR. KLEIN: So the thought was that licensees that enter block four, the further out of bounds they were, the more likely they might get into a situation that required an LAR. But if they were slightly out of bounds, they might be able to show that they really are inbounds by taking credit for other features of the plant.

MEMBER RICCARDELLA: So refresh my memory. Did South Texas do a license amendment?

MS. SMITH: Yes.

MR. SMITH: Yes.

MEMBER CORRADINI: We reviewed that. It's called RoverD, Rover.

MR. SMITH: RoverD.

MEMBER RICCARDELLA: Yes. Understand. I remember reviewing it, I just didn't remember if it

was part of a license amendment or not.

CHAIR REMPE: Okay. Do any of the members or the -- here in the room or members on the phone have any more questions or comments? We do need to also go to public comments before we might possibly close the meeting.

So at this point, too, could members speak up and say if they think they need to have a closed meeting? Looking around the table and it's pretty quiet. What about Pete and Matt, do you guys have any additional questions or comments for a closed meeting?

MEMBER RICCARDELLA: Nope, nothing further from me.

CHAIR REMPE: Okay.

MEMBER SUNSERI: This is Matt. I don't have any additional questions. I thought the flowchart and the technical evaluation report were quite helpful, actually. Thanks.

CHAIR REMPE: Okay. Thank you. So at this point, let's see if any of the public in this room have any questions or comments. And with that, I'm not hearing any, I'll go around and ask members if they have any final closing comments.

MEMBER CORRADINI: People on the line?

CHAIR REMPE: Oh. Are there public

members on the line that want to speak up and make a comment? So not hearing anything, I guess we'll go around the table for closing comments, starting with Member Ballinger.

MEMBER BALLINGER: No further comment.

CHAIR REMPE: Harold?

MEMBER RAY: No, I don't think so.

CHAIR REMPE: Mike?

MEMBER CORRADINI: So, I guess I have a number of comments. Since you've been doing this for a long time, it's kind of not going out with a bang, but a whimper, and that worries me, for two -- for three reasons. One, you have an integrated decision making process which is not standard operating procedure.

You have essentially developed something which could be beneficial, so it seems to me some sort of documentation of that integrated decision making processes would be beneficial for the rest of the staff, because there are going to be other things that linger that could be transformed to use at the technique, right?

But I think you've got to somehow at least talk through the process, because I thought the process, as you walked through in terms of what were

the safety margin -- or what were the set of assumptions, what were essentially the defense in depth measures, what was the safety margins in each of the defense in depth was a way to get you to the final end state that I thought was good, so that's the first thing.

My second thing is documentation of the pieces -- Pete talked about xLPR. I don't know enough to appreciate that, but at least with the TRACE calculations, if they truly are conservative, even though it's a small community, I think some sort of documentation of that would be useful.

MR. SMITH: It's reference 21.

MEMBER CORRADINI: It's reference 21. So there is something out there we can look at?

MS. SMITH: Yes, I don't know if that's public, though, so --

MEMBER CORRADINI: Yes, I'm sure it isn't.

MEMBER RAY: Mike, I'm going to just interject into your question. You used the word it, and you said it was going out with a whimper. What do you mean by it, because --

MEMBER CORRADINI: GSI-191.

MEMBER RAY: Well, all right, but that doesn't end the ongoing process, that closure.

MEMBER CORRADINI: No. The evaluation for the generic letter is going, but what I guess I'm getting at is, what's bothering me is, you have a technical basis document that strikes me as incomplete. It's incomplete because the decision making process is not -- incomplete because I would think there are pieces of the calculation that ought to be properly documented.

And the third part of it, to me, is that if this was the public and the public just by weariness is not around to listen to it, would be confused as to why it's significantly conservative. I mean, I really do think you guys have a case, and I'm not arguing with the case.

I'm just not clear that the document is clear so somebody can look at it and say, a-ha. We've already been worrying about this for a decade when we shouldn't have, or they've developed enough experimental information that now, we feel confident that it is a low safety.

So those are the three things that -- I know it's more work, it takes resources, I understand all that, but it just strikes me that these would be beneficial for the technical basis, not for the evaluation. I think now I finally understand why

that's different.

MS. MARSHALL: Okay, well, if I may, this is Jane Marshall with NRR DSS. A lot of the risk informed decision making processes that we use are documented in other procedures in other places for NRR. So they're not necessarily repeated in this document.

CHAIR REMPE: And the staff tell us this is a new way of doing things earlier in this meeting today?

MS. MARSHALL: It's a new way, broadly, a new way of looking at things across all of NRR's processes, not just isolated to GSI-191 resolution. We're looking at risk informing as many of our processes --

CHAIR REMPE: Right.

MS. MARSHALL: -- as we can, and you know, I would like to highlight, there is a difference between risk informing and risk based, as long as we get through. So, and I know it's easy for some of the members of the public to look at those as the same thing, so I wanted to highlight they are separate processes. NRR has an inner office instruction and some other guidance to staff on risk informing these processes.

MR. BORROMEO: This is Josh Borromeo from the staff. Jane, I think the office instruction you are talking about is LIC-206. It's recent formed decision making for LARs.

MEMBER CORRADINI: And this followed that procedure?

MR. BORROMEO: Probably not, because it was released in June, I think, of this year. June 2019.

MS. MARSHALL: It follows the ideas, but not the processes.

MR. SMITH: This isn't a LAR.

MS. MARSHALL: Yes.

MEMBER CORRADINI: This is what?

MR. SMITH: The TER isn't a LAR, either. So a lot of the license amendment requires --

MEMBER CORRADINI: Oh, oh, I'm sorry.

MR. SMITH: -- and that's the same with Reg Guide 1.174. It's written for license amendment requests, but we still use the ideas from these things --

MEMBER CORRADINI: Okay.

MR. SMITH: -- when we did the evaluation.

MEMBER CORRADINI: What I guess I'm getting at, to put it in a simple thing, I think this

is a good piece of work. It kind of is now going to sit somewhere quietly, but I do think since when I started with the committee, this was a lot of discussion --

MR. SMITH: Right.

MEMBER CORRADINI: -- in 2005 and 2006. And it just strikes me you essentially put a cap on it technically, and it would be good to essentially wrap it up in these three areas. But I think the staff has done a very good job, personally.

CHAIR REMPE: I can come back to your comments, but let me let Matt and Pete have a chance to give their final comments, and then I'd like to discuss what you're saying a bit more, Mike, okay?

MEMBER CORRADINI: Mm-hmm.

CHAIR REMPE: Matt, do you have any final comments?

MEMBER SUNSERI: No, I don't have anything else to add, Joy, thank you.

CHAIR REMPE: Okay. Pete, do you have any comments?

MEMBER RICCARDELLA: Nope, nope, I don't. I just, I'm happy to see the staff actually making use of the xLPR work. Preliminary as it might be, it's important.

CHAIR REMPE: So I know you just joined us, but Walt, did you have any comments you wanted to make while you're on the table?

MEMBER KIRCHNER: No, thank you.

CHAIR REMPE: Okay. So you've listened to what Mike has said. Does the staff -- I mean, he's made discussion a couple of pretty good suggestions, such as documenting the cases and how much margin there is, and to provide someone who's less familiar with the topic an easier to understand path of what occurred here, and to better justify your approach and why it's valid.

Does the staff have the opportunity they might consider these suggestions? Or you're saying, nope, we're done and that's it, we've already got the guidance document out, the industry's happy with it, they said it's going to be easy to follow?

MR. SMITH: I see Mirela's stepping up to the table, so I'm going to let her answer.

MS. GAVRILAS: So this is Mirela Gavrilas of the staff. I think the points that you guys are raising are very important, because it is a paradigm shift. It's not happening in a vacuum, though. I mean, all the principles that have been involved in this decision making are related to 1174.

What is new is the fact that we actually used them for decision making for a decision that's other than a licensing action, and while it didn't occur to us for this -- in this specific context that we should take the next step and see what we can document so that it becomes a generally useful tool for the -- for future decision making, I think you're making a very good point, and we'll certainly consider that.

With regard to the margins that actually gave the staff the confidence to call this a low safety significance scenario or phenomenon, we will want to document that, as well. So I think that you're right. We'll go back and see in the context of knowledge management if we can document the various margins that actually led to the elements of 1174 that actually led us to conclude that this is low safety significance. So we will do that, because it is of value to do. Folks are going to be using this similar approach in the future.

CHAIR REMPE: Because as Mike emphasized, GSI-191 was a pretty hot topic there for a lot of years, and again, you may appreciate having that documented now before staff may retire or move to other topics that they're interested in.

MS. GAVRILAS: And let me give credit to Vic Cusumano, who is not here today, but what Vic always says is, we got here because we worked very hard for the past -- not just the staff, but industry and everybody worked very hard to understand what's going on so that we can make a conclusion that we've presented to you today.

So, and we do want to make sure that we actually document that knowledge in a manner that's transparent and easy for others to follow and easy for the public to understand. It's a very good comment, we'll hear you.

CHAIR REMPE: Okay.

MEMBER RAY: Let me interject here, though, then, because, you know, I went through the AP1000 design certification as the secondary chair. Another reason it occurs to me for doing what Joy and Mike have discussed is, the logic associated with closure of GSI-191, isn't it potentially relevant to future applications for design certification, or standard design approval, or whatnot?

In other words, if it -- the only thing, as I understand it, that we're doing today is closing GSI-191. If I'm a licensee, I've got to do the same thing I've always had to do. I follow the flowchart

up there and do what I'm obligated to do.

But if I'm a potential applicant for a design certification, for example, isn't there information here that I would want to draw upon, whether I was staff or applicant, in the future?

MS. GAVRILAS: I just want to be careful, because we have the standard review plan for applications, in general. We have an effort right now to revise the standard review plan to consider risk information.

In other words, what findings must the staff make before they have reasonable assurance of adequate protection in any of the regulations? So I want to be careful to not convolute this effort with what's going on there. We have to give some thought where to put it.

We have a lot of risk initiatives going on right now in the agency, and to put them all in a cohesive structure is not trivial, it's not easy. This is one of them, and I think we need to figure out where it fits, but we're hearing you that we need to figure out how we can take it beyond what it means to closing GSI-191 and how we can apply what we learned here to other type of regulatory decision making, whatever that decision making may be.

MEMBER RAY: That's fine, and also, as they say, perhaps make it accessible by a potential applicant, not just buried in some staff.

CHAIR REMPE: So is there a way we can help you make sure that this gets done? I mean, we aren't requested to write a letter on this, and we probably won't get into the technical details of the process, but to say some of the aspects that we feel are important and should be documented in a letter.

Again, I'm a member speaking in a subcommittee meeting, and it would have to go through the full ACRS, but if we were to do something like that, does that make this a little more concrete so what we're asking gets done for those members who feel like it should be done?

MS. GAVRILAS: So, we talk about it amongst ourselves that it's, you know, the committee's provocative to ask us to come in front of the committee, and so we've given you the overview to the subcommittee. And if the committee feels that it would be of value to come and talk to the full committee, and the committee wants to write the letter, then by all means, we'll support it.

CHAIR REMPE: Okay, but does it help make sure something gets done is what I'm asking. Yes, we

can do this, but does it matter as far as you feel like, eh, we're going to do it no matter what, you guys -- it's a waste of our time to come down and have to do this --

MS. GAVRILAS: We are committed to basically implicate risk in agency decision making to the maximum extent possible. So this will be one of the things that we will consider. Am I going to say 100 percent? I'm not quite sure what's on their to-do list, so how quickly it gets done --

CHAIR REMPE: Yes.

MS. GAVRILAS: -- may depend, but I think we'll strike the iron while it's hot, and we are committed, the management in NRR is committed to utilizing all the good lessons to have them share about with internal and external stakeholders.

CHAIR REMPE: Do any members want to speak up and say something we should do before we close this, or just --

MEMBER CORRADINI: I'm out. I'm not going to say a word.

CHAIR REMPE: Ron or Harold?

MEMBER RAY: No, I'm just thinking about this for the first time. I would need some more time to reflect on it.

MEMBER CORRADINI: Can I ask Mirela a slightly different way of the question? So have you already thought down the line, you've done a TER, which has shown a -- which has a technical basis for the conclusion.

You now have compliance evaluation guidance, which is being approved, or has been approved, or whatever, right, and it's out on the street. Except for what I'll call knowledge management, which I think is important, are you committed to that, regardless?

MS. GAVRILAS: To the knowledge management?

MEMBER CORRADINI: Yes.

MS. GAVRILAS: Yes.

MEMBER CORRADINI: Okay, fine. That's what I thought you said. I wanted to make sure. Okay.

CHAIR REMPE: So I'm going to close this meeting, unless I hear anything else from Matt and Pete. Going, going, gone, and with that, I'll close this hearing.

(Whereupon, the above-entitled matter went off the record at 2:40 p.m.)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Technical Evaluation of In-vessel Closure Based on Low Safety Significance for Generic Safety Issue - 191

ACRS Subcommittee Meeting

September 16, 2019

Steve Smith, NRR/DSS/STSB
Paul Klein, NRR/DMLR/MCCB
Ashley Smith, NRR/DSS/SRXB

Presentation Outline

- Recap from April 2019 meeting
- Staff technical evaluation (TER) of in-vessel downstream effects (IVDEs) (ML19178A252)
- Comment/resolution since April 2019 meeting
- GL 2004-02 staff review guidance development

Recap from April 2019 Meeting

- Provided background
- Described industry and NRC actions related to Generic Safety Issue (GSI) – 191 and Generic Letter (GL) 2004-02
- Described the approach to address IVDEs
- Committed to making changes to the IVDE TER and providing final version to ACRS

IVDE Safety Significance Approach

- Align agency/industry resources in accordance with safety significance of issue
- Staff TER - evaluate the overall significance of IVDEs, considering new and existing knowledge
  - Safety significance criteria determination used various sources of information
  - Defense in depth is maintained assuming complete blockage of core inlet

Technical Evaluation (TER) Scope

- Evaluation of IVDE safety significance only
- Integrated decision-making:
  - Engineering judgment, qualitative, quantitative, and risk information used
- Not evaluating regulatory compliance
- TER provided supporting information to close GSI-191
- TER will be considered in closing GL 2004-02

Primary Flowpath Maintained

- Uniform bed formation is unlikely
- Breaks that reach core blockage debris threshold are very low frequency
- Long-term core cooling (LTCC) maintained with core inlet 99% blocked
- WCAP-16793 single fuel assembly tests – tolerate high quantities fiber/particulate without precipitates
- WCAP-17788 chemical effects timing - almost all plants go to hot-leg switchover (HLSO) (or equivalent) before precipitation, debris bed disruption expected

Overview – Defense-in-Depth

Core Inlet Blocked	Defense-in-Depth Measures				
	Alternate Flow Paths (AFPs)	Refill RWST/Direct Injection	Operator Action: Start Reactor Coolant Pumps	Hot Leg Switchover	Containment Integrity
	AFP may provide adequate cooling	Cleaner injection water may provide adequate cooling	Disrupts debris bed	Disrupts and bypasses debris bed	Provides additional fission product barrier if fuel cladding fails
	Defense-in-Depth Outcomes				

TRACE Analyses

Various sensitivity studies completed by RES result in the following conclusions:

- Boric acid precipitation (BAP) was not found to inhibit LTCC with significant blockage at the core inlet
- AFPs are a viable option to maintain LTCC for both cold-leg breaks (CLBs) and hot-leg breaks (HLBs)

Staff Technical Evaluation Conclusion

- Staff concluded that IVDEs are of low safety significance for plants that address the key parameters identified in the TER

Safety Significance Criteria

Used available guidance to determine definition of risk

	Lower Risk ← Risk Metric (Δ CDF/Rx Year) → Greater Risk				
Reference	10^{-7} or Lower	10^{-7} - 10^{-6}	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-4} or Higher
RG 1.174	Acceptable		Evaluate	Unacceptable	
SDP	Green		White	Yellow	Red
LIC-504	No Action	Evaluate (Shut Down if CDF > 10^{-3})			
NUREG/BR-0058	No Action			Evaluate	Take Action

Frequency of LOCAs to challenge LTCC via IVDEs

Use of TRACE

- Clarified how TRACE was used to inform conclusions
- Added a table to describe various TRACE sensitivity studies performed

Break Size Sensitivity

- ACRS requested per FA fiber amount/ break size sensitivity
- Compared WCAP-17788 most conservative limit to lower 15 g/FA limit from WCAP-16793
- The 15 g/FA value can be met using the same break size and other inputs except:
  - Fiber penetration value is reduced from the most conservative value (15%) to the second most conservative value (12%)
  - Penetration values from plant specific testing

LOCA Frequencies -xLPR

- Parametric study was conducted using xLPR Version 2 to estimate LOCA frequencies
- A variety of pipe sizes, degradation mechanisms, inspection schedules, and leak detection credit were investigated
- Preliminary results suggest that LOCA frequencies in NUREG-1829 are conservative
- Further sensitivity study is underway to investigate impacts of uncertainties in key variables (e.g., weld residual stress, loads, and cracking frequency)

GL 2004-02 Staff Review Guidance

- Purpose: Provide guidance to the NRC staff to evaluate licensee demonstration of compliance with 10 CFR 50.46(b)(5) for addressing debris impacts
- Status: Issued September 4, 2019 (ML19228A011)

BACKUP SLIDES

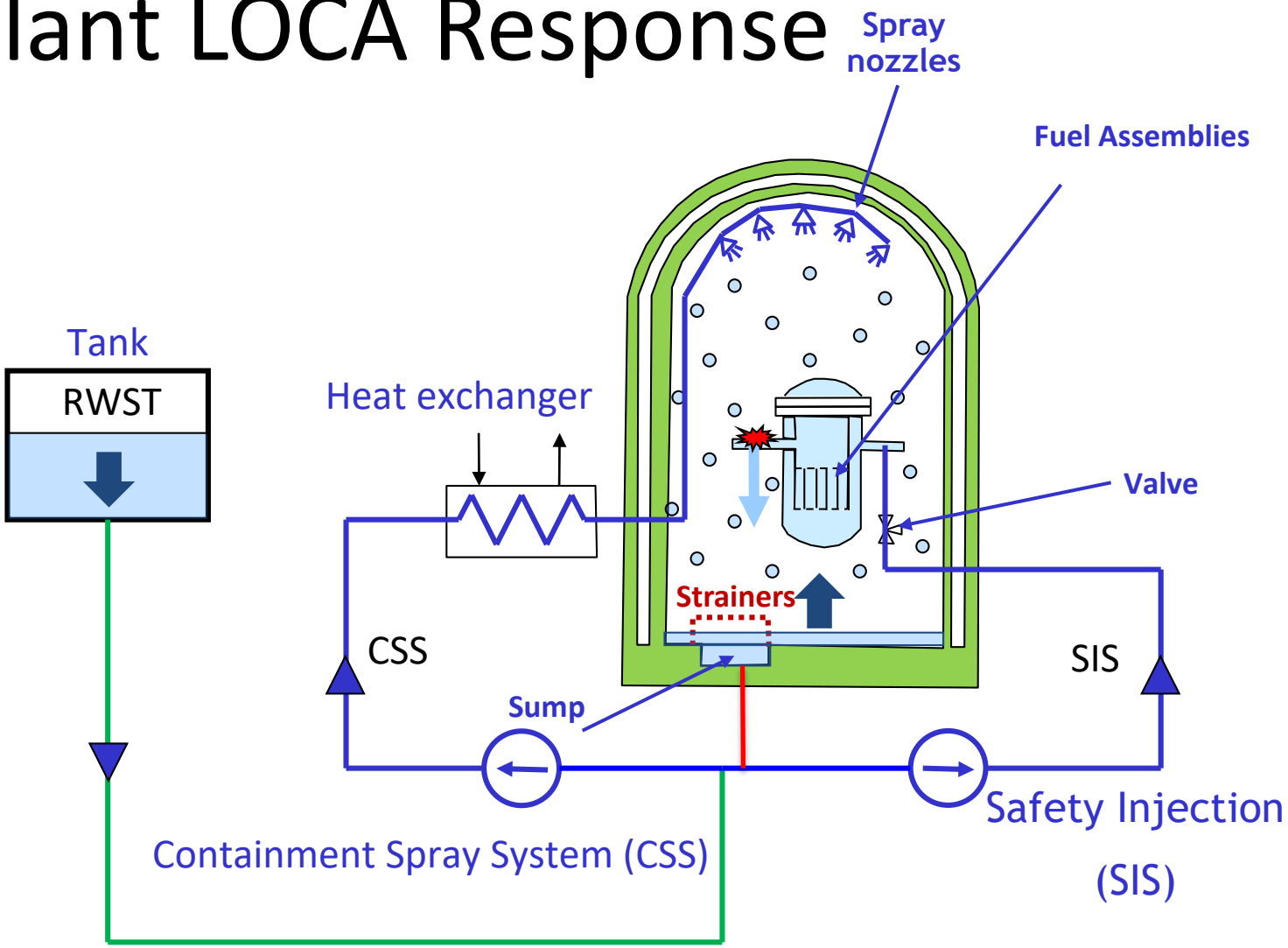
Comment/Resolution ACRS

- TER was revised to address ACRS comments:
  - **Clarified use of TRACE**
  - Staff verified 15 g/FA and 6-inch minimum break size
  - Additional information added to clarify brine testing
  - **Clarified TER safety significance statement**
  - Clarified HLSO based on BAP is in emergency operating procedures
  - Clarified t_{block}, t_{chem}, and K_{max}
  - Clarified why the CLB bounds the HLB
  - Clarified the use of STP assumption for lowest fibrous debris limit
  - Additional language added regarding uniform resistance calculations
  - Clarified that the use of risk numbers developed to define safety significance for use in the TER to define IVDEs only applies to this review

Comment/Resolution
Staff Peer Review and PWROG

- TER was revised to address both staff peer review and PWROG comments, some of which are listed below:
  - Clarity
  - Purpose
  - Safety significance threshold
  - Reliance on TRACE
  - Correction to description of how flows, break size and debris generation are related
  - Applicability to new reactors
  - Loss-of-coolant accident deposition model (LOCADM) as key parameter
  - Sump switchover timing

Plant LOCA Response



Overview – Safety Margin

Attribute	LOCA Size for Debris Generation	Recirculation Swapover Time	Coating Failure Unqualified	Debris Transport	Fiber Penetration	Core Inlet Fiber	Chemical Effects Timing	Hot Leg Swapover Timing
Assumption	6-inch	20 minutes	100% Fine	100% Fines Transport	15%	Uniform	6 Hours	24 Hours Maximum
Most Probable	<6-inch	>30 minutes	<100% Time dependent	Some fines trapped	<15%, Decrease with break size	Non-Uniform	≥24 Hours	Plant Specific
Margin	Less debris is likely	More debris settles before reaching sump, Lower decay heat	Some fail as Chips	<100%	Depends on Plant Design	More debris required to block core	Core inlet unblocked w/o Chemical Effects	Consider actual plant timing
Time in Transient	Initial Recovery	Switchover and Early Recirculation					Long-Term Effects	

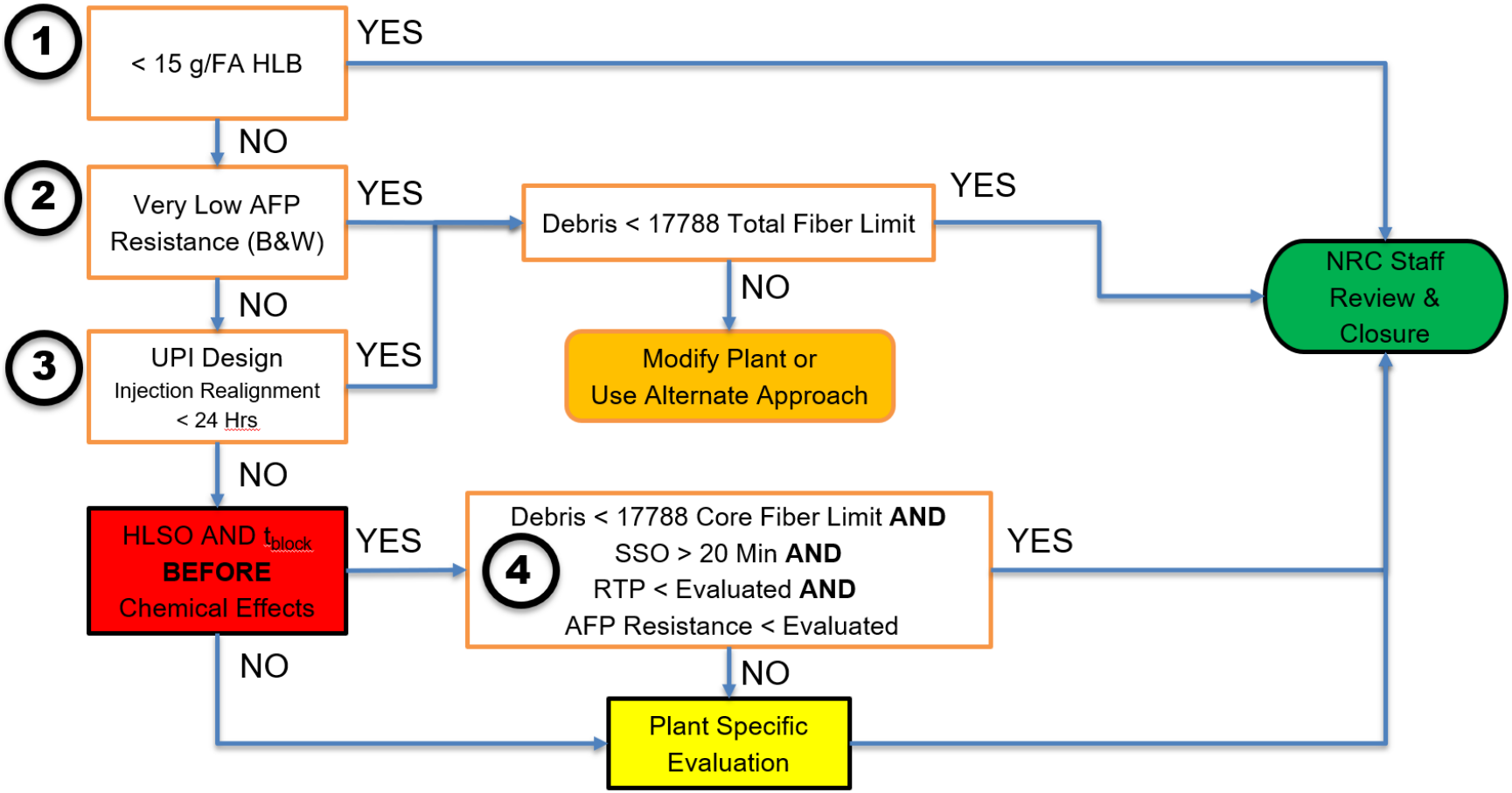
TRACE Analyses

	CLB BAP	HLB BAP/AFP	HLB AFP	CLB AFP
Purpose	Evaluate effects of debris buildup at core inlet on BAP	Evaluate effects of debris buildup at core inlet on BAP and LTCC	Evaluate PWROG conservatisms	Evaluate PWROG conservatisms
Model	DEG, 4-loop W upflow, mid-peaked axial, ANS 79		DEG, CE, top-peaked axial, ANS 79	
Cases/ Sensitivities	- 99-99.9% blocked LCP - 99-100% blocked nozzle -HLSO time, decay heat, axial skew	- 99.5-100% blocked core inlet	-Decay heat -Bypass -Blockage timing -Rate of blockage -HPI flow	-Base case only

Key Parameters

- Initiating event frequency
- HLSO (or equal) to dilute debris, chemicals, BAP
- Chemical timing vs. AFP timing
- Chemical effects methodology
- SSO timing
- Particulate debris amounts
- Fibrous debris amounts
- Minimum ECCS flow
- FA debris capture characteristics
- AFP resistance value
- CLB driving head
- RCS liquid mass
- LOCADM

Staff GL 2004-02 Evaluation



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