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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

and

RELIABILITY AND PRA SUBCOMMITTEE

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WEDNESDAY,

APRIL 5, 2017

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:32 a.m., Michael Corradini and John Stetkar, Co-Chairs, presiding.

COMMITTEE MEMBERS:

MICHAEL L. CORRADINI, Co-Chair

JOHN W. STETKAR, Co-Chair

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

JOY REMPE, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

WILLIAM SHACK*

DESIGNATED FEDERAL OFFICIAL:

DEREK A. WIDMAYER

ALSO PRESENT:

REED ANZALONE, NRR

STEVEN BLOSSOM, STPNOC

ROB ENGEN, STPNOC

C. J. FONG, NRR

WAYNE HARRISON, STPNOC

SHANA HELTON, NRR

ERNIE KEE, STPNOC

PAUL KLEIN, NRR

MARVIN LEWIS, Public Participant*

CANDACE DE MESSIERES, NRR

DOMINIC MUNOZ, ALION*

MIKE MURRAY, STPNOC

LISA REGNER, NRR

DAVID RENCURREL, STPNOC

ANDREW RICHARDS, STPNOC

WES SCHULZ, STPNOC

STEPHEN SMITH, NRR

DON WAKEFIELD, ABS*

MATTHEW YODER, NRR

* Present via telephone

C-O-N-T-E-N-T-S

P R O C E E D I N G S

8:32 a.m.

CO-CHAIR CORRADINI: The meeting will come to order. Good morning. This is a joint meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Thermal Hydraulics and Reliability and Probabilistic Risk Assessment.

My name is Mike Corradini. I'm chairman of the Thermal Hydraulics Subcommittee.

ACRS members in attendance are Ron Ballinger, Matt Sunseri, Harold Ray, Dana Powers, Dennis Bley, John Stetkar, Jose March-Leuba, Walt Kirchner, and Joy Rempe.

We are also joined by Dr. Bill Shack on the phone line as an ACRS consultant.

Derek Widmayer is the ACRS staff and he is the designated federal official for this meeting.

The purpose of today's meeting is to discuss the South Texas Project risk-informed approach to resolve GSI-191.

The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed opinions and positions and actions as appropriate for consideration by the full committee.

The ACRS was established by statute and is governed by the Federal Advisory Act, or FACA. This means that the committee can only speak through its published letter reports and we hold meetings to gather information to support our deliberations.

Interested parties who wish to provide comments can contact our offices requesting time after the Federal Register notice of the meeting is published.

That said, we also set aside time for extemporaneous comments from members of the public attending or listening to our meetings. Written comments are also welcome.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, letter reports, and full transcripts of all full and subcommittee meetings, including all the slides presented at the meeting.

Detailed proceedings for conduct of the ACRS meetings was previously published in the Federal

Register notice of October 17, 2016.

The meeting is open for public attendance and we have received no requests for making oral statements.

A transcript of today's meeting is being kept. Therefore, we request that the meeting participants use the microphones located throughout the meeting room when addressing the subcommittee.

Participants should identify themselves first and speak with sufficient clarity and volume so they may readily be heard.

There is also a telephone bridge line established for this meeting. So we request that participants on the bridge line please keep their phones on mute to minimize interference with the audio reception in the meeting room.

I also understand there's a bridge line for the South Texas experts who are online to participate in discussions and we've already checked that out. It seems to work.

So we request that participants on the bridge line keep their phones on mute as I had requested previously.

At this time I ask that attendees please silence all cell phones and other devices to make the noises -- to minimize disruptions.

I also remind speakers at the front of the table to turn on their microphone indicated by the little green light when you want to speak. And likewise turn off the microphone when you're not speaking.

So, we'll proceed. I'll call on Shana Helton, the deputy director of the Division of Safety Systems of NRR to make introductory comments.

MEMBER SUNSERI: Dr. Corradini, before we get started here I just wanted to announce that due to my connection to Wolf Creek, and due to Wolf Creek's connection to this topic I'm going to recuse myself from any deliberation with the exception of statements of fact. Thank you.

CO-CHAIR CORRADINI: Thank you. Thank you, Matt.

MEMBER REMPE: And by the way, Dr. Shack is on the line. I know there were some questions earlier. I just got an email from him.

CO-CHAIR CORRADINI: Okay, good. We can't wait to hear from him. Shana.

MS. HELTON: Thank you, Dr. Corradini. We appreciate the opportunity to address the subcommittee today.

Before we begin I have some brief opening remarks. And I would like to acknowledge some of the key staff who have been involved with this effort so far.

Lisa Regner is our project manager. You'll hear from her as well as Steve Smith who's been doing a lot of great work on deterministic debris analysis.

We've got Dr. Josh Kaizer here to talk about the TH analysis. We've got C. J. Fong and Candace Pfefferkorn -- I apologize, I'm not going to pronounce your married name correctly, de Messieres, on PRA analysis.

We've also got Paul Klein and Matt Yoder who have been integral to the team evaluating coatings and chemical effects. And we are prepared to answer any questions the subcommittee might have today.

Before we dig in I think it's worth just mentioning a little bit of the background. In 2010 the Commission directed staff to consider a risk-informed method to close GSI-191.

They included some specific direction to be creative and innovative which led to staff efforts in 2012 on closure option 2B for the Generic Letter 2004-02 Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors.

South Texas Project is serving as the pilot plant. We appreciate their efforts to help us move this along to closure.

Some lessons learned that we've learned from the pilot already have greatly benefitted the NRC staff work and have influenced the way we're going to go forward with some of the remaining plants using the risk-informed closure option.

We expect to receive preliminary closure documentation for review from at least two more plants in the next few months.

I want to commend both the NRC staff and the South Texas Project staff and contractors for their creativity and collaboration during this pilot in addressing the challenges that inevitably arose along the way.

We've had several meetings, audits and site visits over the last few years. We've found those to be crucial in understanding both sides of the highly technical issues.

The face-to-face audits especially I think were especially helpful and led to the hybrid method you're going to hear more about today.

I'd also like to express appreciation to the ACRS. We've presented to the ACRS on numerous occasions. I think we're well into double digits.

And we have taken your feedback to heart. And I think it has greatly shaped the path forward that the staff is going to present to you today.

We have definitely benefitted from the insights that we've heard at the subcommittee and the full committee throughout the review process. So, thank you in advance for your questions and I will turn it over to Lisa.

CO-CHAIR CORRADINI: So, before you do that we've been doing this so long all the experts have left the committee.

So you have the next team up.

MEMBER POWERS: I will take a dissenting view.

(Laughter)

CO-CHAIR CORRADINI: I'm sorry. We do have one gray beard left. I apologize.

MEMBER POWERS: I will take another dissenting view.

CO-CHAIR CORRADINI: The reason I bring this up is with the new members here you're going to get some questions that are more background-related.

If it's appropriate for South Texas Project to answer them, or you want to delay until the staff comes up, please let us know so we can be efficient about answering the questions. But I think you'll get a lot of background questions.

MS. REGNER: Okay, great. Thank you for that.

Good morning. My name is Lisa Regner. I'm the PM for the South Texas Project.

The South Texas Project Generic Safety Issue 191 Team last presented to ACRS two years ago almost to the day on the status of this pilot risk-informed review to resolve the safety concerns with containment debris impacts on emergency core and containment cooling function.

A significant amount of work has been completed by the NRC staff, STP staff and its contractors. It's been my privilege to work with these tremendous teams, and I will say without irony that we are very happy to be here today and to hear your feedback.

The NRC's agenda today will cover a short background and overview of this project. We'll hear from the STP team and then the staff will get into the meat of the NRC staff's review and summarize our results to this point.

We have a particular focus on the thermal hydraulics or in-vessel effects and probabilistic risk assessment.

The staff has resolved several significant technical concerns since we last met as Shana mentioned. And I'll give you a preview of a few of these focus areas that the staff will then detail for you after the overview and after STP's presentation.

Finally, I'll explain the remaining actions for the staff to complete this project briefly.

So to start with the background as Shana mentioned in December 2012 the Commission approved the use of a risk-informed option in assessing pressurized water reactors' sump performance considering the effects of debris.

STP requested shortly after that to be the pilot plant for option 2.

This has been a tremendously complex technical review requiring the involvement of 5 divisions and 14 branches in the Office of Nuclear Reactor Regulation.

The NRC and STP staff and contractors met in over 40 public meetings. And there were several other licensees that participated in these meetings that plan to use the risk-informed methodology.

There were over 400 questions that the staff asked. Although many of those that were answered by STP were superseded when the new methodology was submitted.

As Shana mentioned also the NRC conducted 13 audits to support the review including 2 in 2009 to support the STP plant-specific testing.

The staff more recently conducted a containment entry audit and were able to actually observe piping layouts, the quantity of insulation in the containment as well as expected debris flow paths and the actual installed sump strainers.

The most recent audits conducted following the RoverD submittal on thermal hydraulics and risk were invaluable to the staff in understanding the details of the new methodology in resolving concerns.

So, what is RoverD? You'll see this slide. You've probably seen this several times already. It really is a good graphic of the very high-level elements of RoverD.

The licensees methodology change was obviously the most significant turning point of the staff's review since it leveraged both the deterministic aspects and risk methods to simplify the process.

This new process was termed risk over deterministic, or RoverD. And this graphic is -- I do want to give STP credit. This is their graphic.

The key elements, the first element is obviously the deterministic test data. It incorporates the licensees' testing which utilized the staff's approved methods.

The testing established the debris threshold for the emergency core cooling and containment spray systems which both those systems rely on the containment sumps to remain functional through long-term core cooling.

The Casa Grande platform developed by STP's contractor ALION then evaluated several thousand break scenarios to determine the amount of debris generated for each break size, orientation, and location in containment.

These calculations -- and that would be this element.

And then the decision point here is when those two values were compared to determine either success or failure.

So, a success, the threshold was met that fell under the deterministically acceptable.

If it equaled or failed it went into the risk-informed analysis, and that formed RoverD.

And the licensee and tech staff will certainly discuss this in much more detail shortly.

This slide highlights some of the more significant challenges we've resolved, and a few of the topics we'll again discuss in more detail. But I did want to give you just a preview.

As stated earlier, once the methodology changed the use of correlations was eliminated, thus reducing some of the uncertainties in predicting head loss and chemical effects.

Further, the licensee did conduct extensive plant testing to develop conservative threshold values for debris above which cooling system function was not assured.

And once they decided to leverage that testing in the RoverD methodology the majority of the break scenarios became deterministic and aligned with the existing staff-approved guidance.

The licensee also reduced uncertainties associated with assumptions evaluating the debris transport timing, and presumed to complete failure -- decided to assume complete failure of debris from time zero. Again, a more conservative assumption. And obviously time zero is the switchover time for ECCS to draw from the containment sumps.

The licensee resolved epoxy coating impacts in the reactor cavity and also justified the use of RELAP5-3D for long-term core cooling in the thermal hydraulic analysis. Again, we're -- Dr. Josh Kaizer will detail that shortly.

CO-CHAIR CORRADINI: So, before you go on, can I just make sure? Everything downstream effects are primarily deterministic if I understand it, except for large breaks, is that correct?

There was a table in the second supplement from the staff. But I have that approximately right.

MS. REGNER: Yes.

CO-CHAIR CORRADINI: Okay. And the second thing I wanted to make sure is clear is that the approval of RELAP5-3D for use of long-term core cooling is specifically only for South Texas. It's not a generic.

MS. REGNER: Correct. Absolutely. We tried to make that very clear in the SE.

CO-CHAIR CORRADINI: I was trying to read your words to make sure I got it right. That summary is approximately correct.

MS. REGNER: Yes.

CO-CHAIR CORRADINI: Okay.

MR. SMITH: One thing. As far as the large hot leg breaks greater than 15 inches, those were assumed to go to the risk-informed category because it simplified the thermal hydraulic analysis. And Josh will talk about that later.

CO-CHAIR CORRADINI: The cold leg you said?

MR. SMITH: The hot leg. The hot leg greater than 16 inch.

CO-CHAIR CORRADINI: Okay, thank you.

MS. REGNER: Any other questions? Thank

you.

So, the remaining actions. We are actually going through the legal review to finalize the concurrence process for STP's licensing requests.

The staff will publish a final environmental assessment. We hope to present to the full committee of ACRS in May. And obviously resolve ACRS comments.

And we will issue the final decision hopefully sometime this spring. That's the plan.

This concludes the background and overview portion of the staff's presentation and we will return following STP's presentation to discuss our methodology and results in more detail.

CO-CHAIR CORRADINI: So, I have another one that you can postpone at the end if you'd like which is now that this is at least there's a light at the end of the tunnel are there other plants that are considering using this?

MS. REGNER: Portions of it, yes. Yes. There are portions of it that will be used. Both Vogtle and Calvert Cliffs are coming in.

From what I understand they're using a different debris analysis rather than the Casa Grande platform. However, many of the -- yes. They're going to be -- yes.

CO-CHAIR CORRADINI: Okay, thank you.

MS. REGNER: This was intended to set a precedent. Any other questions? Great, thank you.

CO-CHAIR CORRADINI: So, STP will now come up. We have their slides also.

MR. MURRAY: So, good morning. We're going to go through introductions of our team that's here so you'll know who's here from South Texas. And we'll start with the table and then we'll go to the folks over on my right.

So, Mike Murray. I'm the regulatory affairs manager at South Texas Project.

MR. KEE: Ernie Kee. I work with the projects group at South Texas Project.

MR. SCHULZ: I'm Wes Schulz. I'm a mechanical engineer at South Texas.

MR. HARRISON: I'm Wayne Harrison. I'm the lead licensing for the GSI-191 project.

MR. BLOSSOM: I'm Steve Blossom, South Texas Project. I'm the project manager for Generic Safety Issue 191.

MR. ENGEN: I'm Rob Engen. I'm manager of engineering projects at the South Texas Project.

MR. RICHARDS: I'm Drew Richards. I'm a South Texas Project licensing engineer.

MR. RENCURREL: Good morning. My name is Dave Rencurrel. I'm the senior vice president and the executive sponsor for this effort and for this closure effort.

I just want to take one moment and really thank you all for this opportunity to have further dialogue about this.

Just as important is really to thank the staff for their hard work in working towards closure. The work for the staff that we've been doing, and really the many experts we've employed throughout the industry but also through several universities.

I would like to recognize two folks here from Texas A&M, folks we've worked very closely together with, Dr. Hassan and Dr. Vaghetto. I'd really like to thank them for their efforts. And we look forward to your questions.

MR. MURRAY: So, on the phone we have Dominic Munoz from ALION as well as Don Wakefield from ABS. They're our consultants on the phone.

So with that, next slide, please. So

here's our agenda that we're going to follow through.

Lisa did a great job of introducing the first discussions on risk over deterministic process overview.

We introduced this first to the subcommittee in March of 2015 so we had our discussions there. A lot of work has gone on with this process since then.

The process remains practically unchanged from what we discussed in 2015. Small changes in results. And that's what we expected as we tuned it in and answered review questions on our own process.

So the results had small changes. Process remains the same.

We'll discuss the deterministic element of this as well as the risk element. And the regulatory basis, we'll discuss that. And then we'll have a slide on conclusions.

So with that we'll turn it over to Ernie and he'll take us through an additional discussion on the risk over deterministic process.

MR. KEE: So, Lisa obviously just showed this slide and I thank you for that good overview.

So I won't dwell on this a lot except to mention that as Dr. Corradini asked about there is a thermal hydraulics element which we use deterministic numbers from the WCAP-1693 for the acceptance for the fuel blockage which is 15 grams for fuel assembly for the entire Westinghouse fleet.

And I want to say that the risk-informed is probably the operative word here. And what we believe and what I believe we've shown is that although we say there's a risk-informed element that element -- with that element we've shown we believe that we have very strong evidence that we would not expect to see failures.

We're very confident that we would not see failures of the emergency core cooling system in a large break LOCA.

And Wes Schulz will give you background on the deterministic element of this process to give you confidence that the very small risk that we show in this risk-informed piece is undoubtedly covered by the very conservative elements that have been included in the testing that was conducted that we base our conclusions on.

And so I think that's it. It's not a full-on probabilistic risk assessment. It does though use scenarios that are -- use deterministic methodologies as done in Casa Grande and deterministic testing to give great assurance that we will have success of the emergency core cooling system.

CO-CHAIR CORRADINI: So, you can postpone answering this but I want to make sure I get it so I don't forget.

I view this RoverD primarily on sump strainer issues. When I look at downstream issues it's pretty much a binary. If I'm less than 15 grams per assembly I'm good. If I'm at 15 grams or higher I fail. I do a calculation deterministically for those conditions.

Am I misunderstanding the long-term core cooling part of this?

MR. KEE: No, sir. That's -- what you said is correct.

I just want to mention that we -- what we have done along the lines of providing great assurance is for hot leg break the amount of debris that bypasses through the strainer will exceed the 15 grams per fuel assembly.

CO-CHAIR CORRADINI: Yes. We'll come back to that when you bring that up. I just want to make sure I characterize this cartoon as to what it applies to primarily. That's fine. Thank you.

MR. SCHULZ: Good morning again. The deterministic element is the first portion we worked with in this activity. I'm celebrating 15 and a half years on this effort and I think we are almost there.

We're basing this on our -- we use the guidance in the NEI-0407 methodology to evaluate our sump performance so we could respond to Generic Letter 04-02.

Part of that involved strainer testing which we showed the majority of our failure concerns were addressed deterministically.

We did flume tests at Alden Lab in Massachusetts to do strainer head loss testing.

We used our maximum degree loads from different breaks to come up with an overall bounding debris load for this test.

We're basing it on two trains only, STPS-3 independent trains. For the deterministic design basis, there's two trains.

We used a conservative particulate amount and we used a very conservative chemical breeze based on 30 days of continuous spray.

The test was based on -- we used one of our spare modules. It was a full flow, 350 GPM strainer flow during the test.

The flume was designed to emulate the approach velocity and turbulence expected at the sump strainers.

We used debris preparation, debris introduction techniques that were found acceptable by the staff. The staff witnessed our tests.

The tests showed that we ended up with a thin bed condition when we were done with the chemical loading and the quantity of particulates.

The testing showed that with this bounding amount of debris, fiber particulate and chemical, our strainer had sufficient head loss such that our net positive suction head for our containment spray and safety injection pumps was satisfied.

The structural integrity of our strainer was satisfied. Our goals for vortexing and air ingestion were also satisfied for this test amount.

And using the actual debris amounts from this test obviated the need for using a correlation determined head loss for various combinations. So that was our benchmark.

And that's the basis of our deterministic element for this RoverD approach.

MR. HARRISON: I wanted to add, and Wes can elaborate on this very briefly, just to remind the subcommittee that we had replaced our original design strainers with this new design of strainer. So that was our initial response. So these are our new strainers.

MR. SCHULZ: Yes, we installed new strainers in >06 and >07. Each sump has about 1,800 square feet which is about a factor of 12 over the original size strainers.

MEMBER REMPE: Could you remind me a little bit about the tags and your treatment of the tags because I know the staff had a question about it and you said hey, it's not going to be a problem.

Do you have tags? Are the numbers just engraved on the pipes?

MR. SCHULZ: We have tags and we look at that. We showed in the test when we do the testing up at Alden we put some tags in the flume and they did not transport. They did not get up on the strainers.

MEMBER REMPE: So they're just too heavy?

MR. SCHULZ: Yes, they didn't transport.

MEMBER REMPE: Okay, thank you.

CO-CHAIR STETKAR: Wes, I have a couple of questions. I think it's the time to ask these.

You noted in the LAR Supplement 2 that the test, the July 2008 test kind of missed the amounts of some particulates based on what you've learned about the plant since then.

MR. SCHULZ: Right.

CO-CHAIR STETKAR: I want to make sure that I understand the rationale for why you believe that the test still remains conservatively bounding.

As I understand it -- and let me just read these and make sure that I've got it right.

The test used too little unqualified epoxy coating because the amount used during the test was based on a preliminary method to account for the chip size distribution.

The test used too little microtherm debris because it picked an incorrect number out of a preliminary report.

But it used too much inorganic zinc based on current methods to estimate the amount of inorganic zinc.

And it used marinite that's since been

removed from the plant.

So, the net effects as I can understand it is that you asserted that the unqualified epoxy coating and the inorganic zinc kind of behaved the same way, and that you basically had more inorganic zinc in the test -- or the surrogate for it -- than the too small amount of the epoxy coating.

You also asserted that the microtherm and the marinite behave similarly. You had enough excess microtherm in there to make up for the marinite that you pulled out. Is that -- did I get that right?

MR. SCHULZ: We had to do a reconciliation of what the as-tested debris elements and then the current as-analyzed condition of our element. And we did that reconciliation. And we had some RAIs back and forth on that. We did that to the staff's acceptance.

CO-CHAIR STETKAR: Now, I think this is also the place to ask, you performed the test assuming two trains are operating. And I understand why that is bounding for three train operation because you'd have the third screen, and you'd have a lower debris load, or you'd have to generate more debris to get the equivalent delta B across the screens.

What I'm curious about is the single train case. And in particular I'm curious about exactly what flow rate did you assume through each strainer for your two train flow.

Here's where I'm going. If I add up the design flow rates for the high head safety injection, the low head safety injection and the containment spray pumps I get 7,020 GPM.

MR. SCHULZ: That's right.

CO-CHAIR STETKAR: There's statements in the LAR saying to the effect that, well, for the containment spray pumps because we had two trains operating and they discharge to a common header we used standard calculation methods to say that the flow through each pump would be less than the rated flow.

So I have -- in that two train configuration I have less than 7,020 GPM through each strainer, is that correct?

MR. SCHULZ: For that case, yes.

CO-CHAIR STETKAR: Okay. And how much flow did you have through the strainer for that case?

MR. SCHULZ: We looked at -- in the deterministic space we looked at -- our design basis is two trains if they're all operating.

And then later on for the single train which is not part of our deterministic design basis. It's part of our RoverD design basis. We used a different flow rate just for the single train case.

CO-CHAIR STETKAR: I'd like to know the flow rates. In particular I'd like to know the flow rate that you assumed through each strainer for the two train case, and I'd like to know whether you assumed 7,020 GPM through a strainer for the single train case.

The reason is that you're deterministically calculated net positive suction head margin for the two train case, the smallest is 0.7 feet for the containment spray pump.

If I had much more flow through the strainer with the same debris loading I'm going to get a larger delta P and it's not clear to me that I'm going to meet that 0.7 foot margin for the containment spray pump, or the 0.9 foot margin for the low head safety injection pump.

Now, why is this important? In licensing space you always talk about this two train requirement.

In the PRA, the PRA takes credit for one train success for the vast majority of LOCAs. And if one train cannot survive with operation under the debris loading that you used to determine this net positive suction head then the PRA is wrong.

The PRA would either need to be corrected to say that one train cannot go to success, or your RoverD methodology would have to go back and generate a lot smaller amounts of fine -- fiber fines to satisfy the net positive suction head for that single train case.

So, I'd really like to know for your deterministic now net positive suction head how much flow did you use through each strainer for the two train case, and how much flow did you use through a strainer for the one train case.

This is for the deterministic net positive suction head that has nothing to do with the PRA. It's documented in Attachment 1-2 of Supplement 2.

It's strictly a determination of given a debris loading, and a flow through the strainer, and a temperature of the fluid how much net positive suction head do you have.

MR. SCHULZ: For the two train case we used full flows for all three pumps.

CO-CHAIR STETKAR: You want to state that on the record? Because this is on the record. Because as best as I can tell in a follow-up to SER questions the licensee stated that containment spray pumps' flow rates were determined using standard calculational method using a hand calculation.

There are statements in there that says based on two CSS pumps operating to a single ring header that tells me you probably didn't use full CSS flow.

If you did that's good, I'm fine with it. But I want that confirmed on the record that you used, indeed, the whatever it is, 2,800 GPM.

MR. SCHULZ: Yes, 2,800 GPM is the full flow that we used when we did our MPSH calculation.

And that 2,800 comes from doing a calc to show how we get that.

CO-CHAIR STETKAR: It's on the record. I want to follow up with the staff then to make sure that they understood that.

In your two train case you indeed had the equivalent of 14,040 GPM flow through the entire link system.

MR. SCHULZ: Each train has 7,000 GPM in

each. Seven thousand twenty, yes.

CO-CHAIR STETKAR: Okay. That's really important to me. So, thank you.

MR. KEE: So, first I just want to make a couple of comments about single train PRA and so forth.

One point is that for the equipment combination, and we show this in the LAR, that it's actually more limiting downstream if you have a train -- less than two trains, but say a high head on one strainer, and a low head on the other, and a containment spray on a third strainer which is conceivable in life. Probably very unlikely.

And in that case the single train case of course we've greatly overestimated the failure, the risk-informed category because what we did, and I think we've discussed this, and you can just stop me if I'm going over old ground.

But we simply said for the single train case that with one-half the amount of tested debris we fail. We call that a risk.

If we see more than one-half the amount of tested debris in a single train case we throw that to the risk-informed category.

With regard directly to your question, Mr. Stetkar, we did not -- as far as I know we never -- and Dominic's on, but I don't recall ever doing a net positive suction head calculation for a beyond design basis case.

So, that's -- I think what goes to the heart of your question is did we use a larger containment spray flow in the case of a single train operating -- all pumps operating on a single strainer. And that as far as I know was not done as a beyond design basis.

CO-CHAIR STETKAR: Well, can we stop using this beyond design basis stuff.

We have three possible conditions. You have one and only one train running. You've got two and only two trains running. You've got all three trains running.

So let's just talk about it in that context because there's a likelihood that each of those conditions can apply and in the risk assessment there's different conditional likelihoods of core damage.

What I'm trying to understand is that in the LAR there are tables that show me MPSH I'll call it margin, the available MPSH above required for -- as a function of the pump for LHSI, HHSI and containment spray, three different tables, and as a function of sump water temperature because of the viscosity.

So all you did is you took a debris loading, you have a required MPSH, you have an available MPSH that's basically determined by the temperature.

And you subtracted the two, and then from that you can subtract the strainer head loss which is just based on debris and viscosity of the fluid.

Those are all reported for the two train operating case. What I'm trying to clearly understand is was the flow through each strainer in that two train operating case 7,020 GPM.

Or was it less than 7,020 GPM because you reduced the containment spray flow due to the hydraulic head of the common header that both pumps are pumping into.

If it was 7,020 GPM I'm good. If it was less I'm not so good because then I'd like to see the calculation with one and only one train running with 7,020 GPM flow through it to make sure that the MPSH margin for that case is still adequate.

So, do you understand my question? If you can assert and show me because it's not documented in anything I can find, show me where you absolutely used 7,020 GPM flow through each strainer to calculate the results that are reported in Attachment 1-2 of Supplement 2 of the LAR which is the only place they're reported.

But they're reproduced in the SER so the staff has taken credit for that.

If you can show me where that 7,020 GPM is documented or give me assurance that that's what was used I'm happy.

MR. SCHULZ: That's what was used, the 7,020.

CO-CHAIR STETKAR: Okay, then why all of the discussions about the calculated containment spray flow was determined from a hand calculation accounting for the common discharge headers?

MR. SCHULZ: Because the question was how did we determine that maximum flow rate.

CO-CHAIR CORRADINI: I'm sorry, the maximum flow rate is for the rated pump. I took that out of other documents. That is the amount of low that the pump will put out. It will put out 2,800 GPM left to itself at design conditions.

So that if it's discharging into a single header by itself it will put out 2,800 GPM.

MR. SCHULZ: Twenty-eight hundred is the max flow for the low head pumps. And that's our tech spec.

The containment spray pumps, the maximum flow for the containment spray pumps is based on two train operation.

CO-CHAIR CORRADINI: Let me see if I can just simplify it. I want to make sure, I want assurance that under a configuration with one and only one train of equipment operating, with all three pumps in that train running, with the debris loading that you applied to the strainers that I have adequate MPSH for all three pumps in that configuration.

MR. KEE: I want to say that we did not do that. We did not calculate.

And I want to say one other thing about single train which is this. That STP, the way STP is designed 25 percent of the time that single train -- and this is in the PRA, by the way -- goes out the break. So that's failure in the PRA.

And what I said earlier about what we

actually did. So, all you have to have is a low head to succeed. So if you have a low head on another train and a high head on a second train then -- and a containment spray on another train and it happens to be -- so, you only have one train but it happens to be on the right leg you can succeed.

So, that case that we're talking about where we only -- which is a most likely case, I'm going to say the small difference that you may see in having runout flow on the containment spray pump running by itself is more than adequately compensated for by all the other configurations that could be realized that would succeed much more easily.

CO-CHAIR STETKAR: I'm not talking about runout flow, I'm talking about all of the pumps failing.

And I don't want to get into the -- if South Texas can just simply answer the question of do I have adequate net positive suction head for all three pumps under a configuration where I have one and only one train running with all three pumps on that train running I'll be happy. That's the question.

If you haven't done the calculation, please do it. You can do it.

CO-CHAIR CORRADINI: So, why don't we take that away and come back to it and let's move on.

Because I think you're clear on John's question.

MR. SCHULZ: Yes, he's stated it clearly just now. Yes, we're clear on the question.

MR. MURRAY: Any other questions on the deterministic element? We're now at the risk element.

MR. KEE: So, again, I just want to mention that we have great confidence based on the work we've done in this effort.

For example, the amount of chemicals that are produced. We have confidence that we tested more than what we would ever expect to see in South Texas Project chemistry.

And that as Wes mentioned I just want to reinforce that, that we didn't just take the debris at the location in the test. We found the location that produced the most debris all around the plant and put that much -- from large breaks and put that much in the test.

That's what we mean when we talk about deterministic. We attempted to greatly overestimate the amount of debris that would arrive on the strainer.

And that's why we have confidence that even though we call these -- we put these scenarios in the risk bucket that exceed 192 pounds of fine fiber we are very confident that we would not see failure on a strainer in a large break LOCA.

CO-CHAIR CORRADINI: So, I have a feeling that Dr. Shack has a question here. Bill, do you want to ask your question? Since I know you had one, at least to me privately.

MR. SHACK: Yes. This just concerns the debris generation and transport that you have.

There are 45 wells that generate fine fiber in excess of 192 pound acceptance levels from the July 2008 test.

And in those wells they -- throwing out the one that in fact exceeds it by about 20 pounds there are wells that range from 14 inches to 22 inches.

And yet the transported fiber is the same to a tenth of a pound.

Why is there so little difference in transported fiber with such a large variation in break size and location?

MR. KEE: Yes, sir. This is Ernie Kee. The way we do this analysis also involves a significant amount of conservatism I'll say because of the way we estimate the debris generated at any location.

And that is we look all -- so, for directional breaks we look at one degree increments. I don't want to get this wrong. And Dominic's here. He can correct me if I'm wrong.

I believe it's one-hundredth of an inch increments shells going out, hemispherical shells.

And the shells also double-ended -- I'll mention this in a minute -- are also checked at that kind of an increment.

So, what you see there, and we did a lot of work on I'll call it convergence, but it's basically the accuracy of the smallest break size that goes to failure. And we even have a figure in our submittal that shows how we look all around and find the smallest break at any location that goes to failure.

So there could be larger breaks that what we call failure, go to failure, and produce more debris. But we don't include those in our estimates.

We take the smallest one that generates the highest frequency.

And because we're so careful those debris amounts are very close to 191.78.

Now, why do we have one that's greater than that? So, when we get to the full diameter of the pipe we're doing these hundredth of an inch increments out to the full diameter of the pipe.

When we hit that diameter we say it's double-ended. And that -- this is in NEI 04-07, it tells you how to do this.

Then you assume a full spherical zone of influence.

And so that's kind of a discontinuity if you will there. And so when you go to that much larger size there's a step, you know, you double the size of the sphere of influence I guess you'd say. So you get a step increase.

CO-CHAIR CORRADINI: Bill?

MR. SHACK: Okay, so you're saying that the 12.814 minimum diameter one is in fact a double-ended break.

MR. KEE: Yes, sir.

MR. SHACK: And all the others are partial breaks?

MR. KEE: Yes, sir. That's on the surge line. It's actually a 16-inch pipe, but the inside diameter is 12.814 inches.

MR. SHACK: Okay. I guess it's a similar argument. Again, it surprised me that you got your 192 for the 2008 test with a ZOI of 7D, and yet when you go to the 17D ZOI for the -- calculations there's only one location with greater than the 0.2 pounds of fiber generated.

Again, it seems very insensitive to ZOI size which I would have thought would have made a big difference.

MR. KEE: Yes, sir. It's a little difficult to get your head wrapped around this.

What we did was we tested an amount of debris which was -- Wes explained how that was done. We conducted a test. And also Lisa addressed this in her remarks.

And that test showed that we could succeed with that much fine fiber, and with everything else in there. I might say throwing in the kitchen sink. I mean, if you saw the thing it looked like it was painted with this aluminum oxyhydroxide. So, that's what we tested.

Now, what do we do now to determine risk-informed category or deterministic category? That amount that we tested that we're sure that we at least succeed with, at least deterministically succeed with we look as I mentioned carefully at each location where we look for the smallest break that will produce that much.

And if we see that much we stop and we say, okay, beyond this size it's failure.

So, there's a little bit of a disconnect there between what we tested and how the new requirement for the 17D non-dimensional ZOI -- that's just for fiber -- came about.

CO-CHAIR CORRADINI: So, I'm trying to listen to this because this one is one of the things that is different from the testing.

So, can you try me one more time on that? Because I didn't understand the explanation. I'm sorry. So maybe less words.

What you're telling me is it didn't matter because of what you tested? So that what you tested bounded whether it's 7 or 17? That's what I think you said, but I'm not.

MR. KEE: I'm sorry if I confused. But it is --

CO-CHAIR CORRADINI: Because I had the same question Bill did and I didn't get clear.

MR. KEE: Let me just say we tested a certain amount of debris on the strainer.

MR. SHACK: The certain amount of debris you tested in 2008 was based on the largest amount of debris you expected to get for the ZOI of 7D.

MR. KEE: Yes, sir.

MR. SHACK: Now you switched to a 17D ZOI and there's only one location that significantly exceeds that thing that you calculated with the 7 ZOI which just seems a little surprising to me.

CO-CHAIR CORRADINI: So Bill, I think we have another helper.

MR. SMITH: This is Steve Smith from the staff.

So, the way that the debris amounts were calculated for the risk-informed evaluation, they found the smallest break size. You know, it might have been a 27-inch pipe but it might have only been a 12-inch break on that pipe.

So that's why you're only seeing -- they were just looking for whatever -- they only looked for 192 pounds of debris. As soon as they got there they stopped calculating.

So that's why all these amounts look the same.

I have a slide in my presentation that will show how much you would actually get from a full double-ended guillotine break from some of these larger pipes.

MR. HARRISON: One more clarification. When we did the search for that smallest break we used a 17D ZOI for those breaks in that break search.

CO-CHAIR STETKAR: Bill Shack, this is Stetkar.

Are you concerned only about the fiber, or are you concerned about the total amount of particulate debris generated also?

MR. SHACK: The fiber is what most concerns me.

CO-CHAIR STETKAR: Okay, okay, I just wanted to make sure. Never mind then.

CO-CHAIR CORRADINI: Okay, so we're going to defer because staff has an explanation that might help us.

Let me summarize. What I heard is because you found the limit on a double-ended guillotine break -- and I'm going to use a number that's probably wrong -- 12 point something, any partial of a bigger pipe greater than that was covered by the double-ended guillotine in a spherical zone of influence.

So that's why 7 and 17 is relatively insensitive. That's what I think I heard.

MR. SHACK: I think Steve Smith had the right answer. That is, they just quit when they got to 192.

CO-CHAIR CORRADINI: Right. Regardless of how they got there. But the smallest pipe that got them there was much less than -- was 12 point or whatever it is. I'm not going to try to give you the number, it's probably wrong. I have 12.4 in my notes.

MR. KEE: So that's -- we're using the current ZOI sizes in our deterministic calculation for debris generation and transport. That's all done deterministically using 17D.

And exactly like Steve said, when we find a break that generates and transports then we throw it to risk.

CO-CHAIR CORRADINI: Okay.

MR. KEE: On this slide, moving on, the detailed evaluation as I just said is done with NEI 04-07 so that's been reviewed by the staff.

And it was mentioned that some of the ZOIs we used we had to go back and make sure that we bounded all those. And we did that in our application.

CO-CHAIR STETKAR: Again, I'm not quite sure where to ask these questions so I'll ask them here because it isn't particularly PRA related yet.

There's a difference between Supplement 2 and Supplement 3 on the amount of eroded fiber fines that were included in the analysis.

And I read part of that story, but it's kind of hard to follow.

So, I'll just point to, there's a Table 3 in each supplement. And the difference in that table is that in Supplement 3 for recirculation, so the amount of small pieces in the pool, in the containment, is 63.5 percent of the small chunks get held up and are subject to this 7 percent erosion.

In Supplement 2, 23.8 percent was held up and was subject to the 7 percent erosion.

So what's the difference between

Supplement 2 and Supplement 3 in the amount of small pieces that are in the sump? Why are more small pieces in the sump?

Because I need to understand that to get to my second question.

MR. KEE: Yes, sir. So that may be an artifact of the analysis.

But the bottom line is when -- in Supplement 2 we've always had small pieces that land in the sump. They fall to the bottom. They don't get transported to the strainer.

But under those flow conditions they could erode to fines and then therefore get transported to the strainer.

So we added all that difference between -- I don't remember the exact numbers, but that difference you see was the difference, the amount of small fiber that arrived in the sump that we then assumed was eroded, that we did not assume was eroded in Supplement 2. And that also produces slightly smaller --

CO-CHAIR STETKAR: Oh, so the difference, the difference. Let me make sure I say it back so I understand it.

That difference, let’s call it 40 percent. Round numbers. That 40 percent was assumed to be not eroded in Supplement 2, but you eroded it in Supplement 3. Is that?

MR. KEE: Yes, sir.

CO-CHAIR STETKAR: Okay. Now, let me make a note here. I’m a slow writer so bear with me.

CO-CHAIR CORRADINI: You have only a few more seconds.

CO-CHAIR STETKAR: No, I don’t. In Supplement 3 now -- if I compare Supplement 3 to Supplement 2 where you go through the tables of weld sizes and locations and all that stuff, I actually did for -- I didn’t want to do this but I had to do it because that’s just what I am.

I compared the welds line by line and I noticed that in Supplement 3 the weld sizes - the vast majority of them are smaller than Supplement 2.

Some of them are the same size, for some reason. But the vast majority of them are smaller in Supplement 3 to Supplement 2.

Is that because -- is that related to this extra 40 percent, the amount of smalls that I can generate?

MR. KEE: Yes, sir.

CO-CHAIR STETKAR: Okay. Okay. I just wanted to make sure why those sizes went down, that it was related to this erosion effect so that in effect a smaller break will generate more debris that you then erode and get more fiber fines to get to your 192 pounds or whatever.

MR. KEE: Effectively, yes.

CO-CHAIR STETKAR: Thank you.

MR. KEE: Are you done?

CO-CHAIR STETKAR: I am done for now.

MR. KEE: Can you continue? So we talked -- so we kind of talked about the deterministic tests, how we -- and how that was done and as a consequence of this debris generation transport in comparison against the test we found 53 locations that we identified as being in the risk-informed category.

And all those are large break LOCAs, as commonly accepted, at least in the South Texas Project PRA, and so the kind of interesting thing that we did here that's maybe, I think, very bounding in terms of risk assessment and so, again, we want to ensure that that deterministic test - the margin in that test that we believe exists due to the assumptions we made is -

it's low risk.

But what we did was for each one of those breaks at the smallest diameter against the - at the break that goes - the 53 we say all those are core damage and look at what the value is for that against the guidelines in the Reg. Guide 1.174.

So that's the basic approach that we took, a scenario-based approach where we had great certainty about the deterministic values that we worked against - the deterministic process that we use and made sure that that margin that's included in the deterministic assessment is small, above that.

So moving to the next, Slide 6, we are in the downstream of the strainer. As Wes mentioned, we put in much larger strainers, even though they had smaller diameters than the ones we had before. They were very large.

And so there - some of the debris is passed downstream through that great large surface area. Even though there is a small amount per square inch it amounts to fair amount.

So that's a concern to core cooling and we have testing that was done - again, very conservative testing that included chemicals that, based on our testing that we have done in house, we don't believe will be, at least in those kind of amounts that were tested that in a cold-leg break we showed that we would not exceed the amount that was tested in that deterministic test that I mentioned, WCAPS 16793.

But we couldn't show that for hot-leg break, right, because all the flow goes through the - through the core in that case. And so we conservatively, again, did thermal hydraulics analysis and we assumed that the barrel baffle region and the core, as soon as it hit 15 grams per fuel assembly, so that's just the core - 15 grams per fuel assembly - as soon as we hit that number we assumed that all flow up through the core and the bypass of the core - the barrel baffle bypass - was blocked. Okay. And then we showed that with that conservative assumption in place we do not exceed -- 800 degrees was our acceptable criteria for that.

CO-CHAIR CORRADINI: So here's where I have a number of questions. So if I read the -- I get confused on the supplements and which SE I am reading --

MR. KEE: This didn't --

CO-CHAIR CORRADINI: -- but in one of --

in one of these things that I read the analysis by STP basically said that with this block all the flow basically goes back up the down comer, through the steam generator, gets a little bit of boiling, comes out the hot-legs and then goes out the break. And in that process there is enough of it that drains down that keeps the core cool. Do I have that approximately right?

MR. KEE: More or less.

CO-CHAIR CORRADINI: Correct me where I am wrong.

MR. KEE: Yes, sir. The S -- there are other bypass flow paths, at least -- so there is -- let's just say three.

CO-CHAIR CORRADINI: I count six. You listed six.

MR. KEE: There are six, but the -- when we get done there's only three remaining, really --

CO-CHAIR CORRADINI: Okay.

MR. KEE: - that we - we need to think about. The South Texas Project has what's upper head cooling so and we have an inverted top hat design and we have done some stuff. You know, in other words, that's probably irrelevant to this discussion.

CO-CHAIR CORRADINI: But there is a - there is a - if I might just interrupt you - I apologize. But the reason you brought that up - that's good, because I thought that was important.

But in your analysis you said that's not that important. It's just the back flow through the hot-legs. It's enough to keep everything cool and that's the crux of why I want to understand this.

MR. KEE: Yeah. I only brought it up -

MR. MURRAY: I know that the staff has some good cartoons, I think, that -

CO-CHAIR CORRADINI: Okay. Good.

MR. MURRAY: - that shows that picture and I think that that would be -

CO-CHAIR CORRADINI: Better saved for the staff?

MR. MURRAY: - better saved for the staff discussion because the cartoon is very useful.

CO-CHAIR CORRADINI: Okay. Well, the staff is grinning and happy over there. So we will let them - going to let them have that - yes, sir.

MR. KEE: So -

CO-CHAIR CORRADINI: And then the - let me make sure that I - I had another one here but -

MR. KEE: I just brought up that one nuance because it's the difference between Supplement 2 and 3.

CO-CHAIR CORRADINI: Right. Right. Because you show calculations that show that with the deterministic calculation - again, I got to get back to this table because they got it all crazy - is that anything over 16 inches you essentially go to a risk-informed analysis, if I remember correctly, with the pipe size.

MR. KEE: That's correct.

CO-CHAIR CORRADINI: Anything below is a deterministic calculation which now is the RELAP3 calculation. So let's stay below. In the those calculations below it's this back flow that keeps you good.

And is that generic or is that specific to South Texas? That is, it seems to me this is a logical thing. If I am going to block the inlet to the core I am going to get a back flow up the down comer and around the bend and through and this is applicable to almost any PWR. Am I missing something?

MR. KEE: No, sir.

CO-CHAIR CORRADINI: Good. All right.

Thank you. Keep on going.

MEMBER REMPE: While you are on the deterministic calculation, would the breaks assumed on these smaller pipes - were they always assumed to be at the bottom of the pipe?

MR. KEE: We actually studied that years ago and we wound up finding that there wasn't a strong correlation there. So we actually put them in the center.

MEMBER REMPE: Okay. Thank you.

MR. KEE: So we looked at the top, the side and the bottom. We would have thought the bottom would have - you would think the bottom was worse but it doesn't turn out that way.

CO-CHAIR CORRADINI: Keep on going.

MEMBER KIRCHNER: Just for clarification then, so the flow rate is such that in the case of the upper head spray nozzle is that the flow rate essentially fills up the down comer and then subsequently fills the upper head and so that flow rate is much greater than the loss out the break so that it could actually raise the level in the vessel and fill it up and overflow into the upper head?

MR. KEE: Yeah. So, again, I believe the

staff will address all this. But just very briefly, the initial cooling comes from flow through the upper head spray and down through the CRDM drive tubes, okay, and lands on top of the core.

So that's the initial, and then later, you know, we eventually overcome the steam generator tube levels and go over and it comes that way.

MEMBER KIRCHNER: Okay. Thank you.

CO-CHAIR CORRADINI: Okay. So I told you to go on and now I am going to - I fibbed. So you chose the most limiting CCFL and I am curious about, and maybe you'll wait for the staff to say that - I am curious about the variation then and the need for the upper head spray nozzle effects.

I am also curious about the timing - the switch over timing - because it would seem to me that has a big impact based on decay.

In both of those cases you chose the earliest and the most conservative situations, as I understand what I read.

MR. KEE: Right. So that time that we chose 360 seconds beyond the time of switch over is, as I mentioned, when we achieve 15 grams per fuel assembly. That's where we know that we tested the flow was impeded to the extent that we may not succeed on clad temperature of that 800 degrees.

So the second piece of conservatism there is that we - there is also the - you'd have to block not only the fuel assemblies but you also have to block the flow area in the barrel baffle bypass, which has much larger channels to go through.

It's pretty unlikely those would get blocked. But so -

CO-CHAIR CORRADINI: Okay. That's -

MR. KEE: - so there is a lot of conservatism in that.

CO-CHAIR CORRADINI: - that's one of the six that you disallowed from being -

MR. KEE: We disallowed all that.

CO-CHAIR CORRADINI: Okay. Thank you.

MEMBER REMPE: I am sorry to ask again, but just to make sure, you did sensitivity studies on the thermal hydraulics evaluations and determined a break location wasn't important?

I know I've read about that you looked at how much debris was generated. But did you do something on the thermal hydraulics evaluation to look at drain down times and things like that to look at break location?

MR. KEE: We did not.

MEMBER REMPE: That's what I thought. Okay.

MR. KEE: We had one - yes.

MEMBER REMPE: Thank you.

CO-CHAIR CORRADINI: Keep on going.

MR. KEE: And in addition we ran containment cases which actually we coupled with the thermal hydraulics with MELCOR.

And in those cases, as Wes mentioned and we have the question from Mr. Stetkar, but we assumed, as is asked for in Reg Guide 1.82 under certain - under conditions that we need at South Texas that you have - you need to assume a conservatively low containment pressure, at the same time assume a conservatively high sump temperature.

And so what we did was we used very optimistic all trains running case for the - for the low pressure case, you know, so that - but if you use that temperature from that case it would be a very low sump temperature. So that's what's recognized in the guidance.

And so for the high sump temperature, we said no, there is not so many trains working. The heat exchanges are failed and so on and so forth.

So we went - I won't call it - I'll call it conservatively low cooling capability to achieve that conservatively high temperature of the sump water with conservatively low temperature or pressure in the containment and that's how that was done and we showed that we did not get air evolution beyond the requirement and we did not get flashing evolutions of steam through the - through the pressure drop we measured in the test and so forth.

The other feature of South Texas Project that is, in my opinion, important here is that even if we don't expect to see core damage, even if we do have core damage, of course, the - we were starting off with a LOCA. So that barrier is breached, and then the fuel cladding would be breached. So we would get a radioactive particles in containment.

The way South Texas is designed the reactor compartment fan coolers, the containment heat removal system, at least a major part of the containment heat removal system, does not rely on the sump at all. So it's completely independent and capable of keeping the containment below failure pressure and temperatures.

CO-CHAIR CORRADINI: And this is unique to South Texas?

MR. KEE: I don't believe it is. I believe - I believe that's a feature.

CO-CHAIR CORRADINI: Okay. But the most unique feature that essentially is an independent cooling mechanism?

MR. KEE: It - well, actually it was cleverly designed this way and so, you know, I think it's a clever design. There is a common mode failure which is - which is containment CCW. But -

CO-CHAIR CORRADINI: That's what I was guessing. That's the only - okay.

MR. KEE: Yeah. Oh. And so now, I believe, Wayne, you have - Wayne Harrison. Oh, I am sorry. We do want to mention the history of the evolution of these risk estimates that we have made over the - since 2015 when we initially started this process and they really, as someone mentioned, they haven't changed significantly over time, although we have added various elements that increase the conservatism, for instance, like the introduction of erosion of smalls and so on and so forth. But probably the big - yeah.

MR. MURRAY: In the interest of time, unless there is questions there -

CO-CHAIR CORRADINI: There is. There is. I know - I know, Pete, we have a question over here and I think Dr. Shack may have one. Go ahead.

CO-CHAIR STETKAR: Okay. So when I looked at - I asked my previous questions to make sure that I understood things, and I do. So when I look at the comparison between the results in Supplement 3 Table 9 to Supplement 2 Table 9 now which shows much more detail than on this slide, I noticed some curiosities and in particular I just want to get these on the record.

For case one, when two trains are operating, the Supplement 3 delta CDF is hotter than Supplement 2, as I would expect, for the continuum break model, both cases - both geometric and arithmetic averaging, and for the double-ended guillotine break only model for geometric averaging.

However, for the double-ended guillotine break arithmetic averaging, this Supplement 3 delta CDF is less than Supplement 2. That’s curious.

What’s more curious to me is that case

two, with only one train operating the continuum break model, Supplement 3 is less than Supplement 2 for both cases and that - it's greater than Supplement 2 for the double-ended guillotine break model.

But if I zero in on the biggest curiosity I have why in Supplement 3, if I have only one train operating, is the delta CDF less than Supplement 2, given the fact that I have both more break locations and smaller break sizes for Supplement 3?

Both of those conditions should make my delta CDF hotter for Supplement 3 compared to Supplement 2 uniformly. So why is it smaller?

MR. KEE: So this is probably all my fault. But in this double-ended guillotine break model -

CO-CHAIR STETKAR: Let's - Ernie, let's - in the interest of time, let's just look at the continuum break model because that's my biggest source of curiosity. Forget the double-ended guillotine break.

MR. KEE: Oh, I am not looking at the -

CO-CHAIR STETKAR: Let's think about the continuum break model, single for two train - two or three trains operating, the behavior qualitatively is as I would expect it. Supplement 3 is worse than Supplement 2. I can't do all the math but I'll -

MR. KEE: So we changed - I mean, we -

CO-CHAIR STETKAR: No, let me finish. In the continuum break model with only one train running Supplement 3 is better than Supplement 2, which is contrary to what I would expect qualitatively because in Supplement 3 I had both more breaks and I have smaller break sizes. So I do not understand if I get down to the specific - biggest concern, why, for a single train operating in Supplement 3, is the delta CDF less than it is for Supplement 2 in the continuum break model.

MR. KEE: Well, I am prepared to answer that question.

CO-CHAIR STETKAR: Okay. I've got it on record.

MR. KEE: So we -

CO-CHAIR STETKAR: Do you understand the question?

MR. KEE: Well, I'll - yeah, I'll provide a full explanation at a later date.

CO-CHAIR STETKAR: Because - because if I don't understand that at the qualitative - I'll get this on the record just so it's there - why should I have any confidence in any of those numbers? Because I certainly can't reproduce them myself. And if they don't behave qualitatively the way I'd expect -

MR. KEE: So, I mean, I think I know where you're going and South Texas is going to come back and ask you that. But my impression was staff did a bounding analysis that -

CO-CHAIR STETKAR: I don't care about the bounding analysis. I am trying to understand what is in the license amendment request documentation that has been submitted by the licensee.

MR. KEE: Okay. Fine.

CO-CHAIR STETKAR: That's what I am trying to understand. I don't care -

MR. KEE: I understand, but my way of looking at -

CO-CHAIR STETKAR: There is different issues here, Mike, but if their calculations are wrong for some reason then the only thing that we have to rely on is the staff's bounding stuff.

CO-CHAIR CORRADINI: So let's just move on.

MR. MURRAY: So move on. We will find -

we will provide an - we will provide an answer. Ernie, let's move forward.

MR. KEE: Next slide.

MR. MURRAY: Were there any other questions in this area?

CO-CHAIR CORRADINI: I don't know. Let me just - let me just check. Bill, did you have a question or has John superseded you?

MR. SHACK: We all have questions about the continuum model and the DET model. But I think those are really addressed by the staff coming up.

CO-CHAIR CORRADINI: Okay. Thank you, Bill. Go ahead.

MR. HARRISON: I'll speak briefly about the regulatory implementation. There has not been - there has been very little change in the regulatory implementation.

We have regulatory - license amendment request and exemptions. The license amendment request is based on a change in methodology from 50.59 for partially and then we also have, as we mentioned before, a debris - added a debris-specific action in the emergency core cooling system and the containment spray system technical specifications that's based on a debris-only condition and has a 90-day completion time.

With respect to the methodology change, we described that in our updated file safety analysis report we make the appropriate changes to the general design criteria descriptions, the engineers' safety features section Chapter 6. The changes that we made in Supplement 3 is we added an appendix to - Chapter 6 to the updated final safety analysis report to describe the debris resolution.

The reporting requirements that are expected to be met and the limitations on change control and we added those to be consistent with the proposed criteria in the proposed 10 CFR 50.46 Charlie rule change. So that makes us, you know, more in alignment with that proposed rule change.

The exemptions that we had proposed are also in alignment with the proposed rule change and that's for 50.46 Alpha One, other properties, general design criteria, and 35 for emergency core cooling system, general design criterion 38 for containment heat removal and general design criterion 41 for containment cleanup.

And as it states here, those exemptions

apply only for the effects of debris. We think we achieved alignment with the proposed rule change and are pretty well on our way to doing - implementing changes in our - in our documents on site.

CO-CHAIR STETKAR: Wayne, the - I was looking at the tech specs and the - that discussion of change control.

Couple of questions - I am not familiar with South Texas' tech specs but it's clear that the debris issues are restricted to only modes one, two and three.

MR. HARRISON: That's correct, and that's why the tech specs are structured.

CO-CHAIR STETKAR: Okay. In mode four, what's the maximum pressure that I can have in the reactor coolant system in mode four?

MR. HARRISON: Wes, can you help me out there? I think it's a transition mode and I think it's, like, 400, 450.

CO-CHAIR STETKAR: I want the maximum. I don't want the minimum. So it's -

MR. MURRAY: So basically our mode change for mode four is what you're interested in, right?

CO-CHAIR STETKAR: Yeah. What -

MR. MURRAY: Where we transition from four to three is really what you're asking, correct?

CO-CHAIR STETKAR: Exactly. Yeah.

MR. MURRAY: So we will look it up and make sure -

CO-CHAIR STETKAR: Okay. And while you're looking up stuff, can - am I allowed to remove two trains of ECCS from operation in mode four or do I need all three trains, knowing mode three you need all three trains?

MR. HARRISON: As I recall, you need to maintain a high head - at least one high head system in mode four.

CO-CHAIR STETKAR: Okay. But where I am trying to get to, quite honestly, is can I have one and only one train of ECCS available in mode four with pressure at somewhere around 2,000 pounds?

MR. HARRISON: No, you cannot. I'll check that for you.

CO-CHAIR STETKAR: Check that please, because -

MR. HARRISON: I'll confirm that for you but I am pretty sure it is.

CO-CHAIR STETKAR: I wasn't - I wasn't

sure I could follow up there. Let me, in the interest of time here - under change - well, curiosity - the tech spec now says for ECCS, so if I look at 3's 345.2 for ECCS it says be in hot standby within six hours and hot shut down in the next six hours and that’s apparently aligned with other things in the tech specs.

For containment spray it says be in hot standby in six hours and cold shut down within 30 hours.

MR. HARRISON: We used to align that with the tech specs as well.

CO-CHAIR STETKAR: Okay. So now if I am an operator, because the stuff in the sump affects everybody - if I am an operator and I am informed that I am now in this limiting condition for operation, and I don’t satisfy the first part, now as a operator I need to be in hot standby in six hours.

I need to be in hot shut down in the next six hours and within 24 hours after that I need to be in cold shut down. Is that correct?

MR. HARRISON: Yes, sir. You have to - you have to apply every tech spec that applies.

CO-CHAIR STETKAR: Okay. So it’s not

clear to me why the distinction on ECCS hot shut down within six hours since you're going to have to go to cold shut down anyway because it - the debris affects everything?

MR. HARRISON: Well, the brief - I guess the brief response to that is we just limited it to changing the tech specs as it applied to debris and if you didn't want to go -

CO-CHAIR STETKAR: I got you. It's just - sure, I - you say a lot of things about trying to keep things simple for the operators and you don't want to use risk-informed tech specs for this because you say the risk informed tech specs make things more complicated and they are not as clear to the operators, which I found awfully troubling because if that's the case you better not have risk-informed tech specs at all, and you do. I'll just say that as a rhetorical -

MR. HARRISON: I think our operators are very familiar with our risk-informed tech specs.

CO-CHAIR STETKAR: And if that's the case, why didn't you risk inform this one?

MR. HARRISON: We had - we had -

CO-CHAIR STETKAR: Why do you need 90 days to clean up stuff versus 30 days for everything else, which is the backstop for the risk-informed tech specs. I'll ask the staff about that.

In terms of the change control, there are statements in there that say, and it's listed two, it identifies a list of items that are key aspects of the methodology that would need, in my understanding, NRC review before they are changed.

MR. HARRISON: Yes, sir.

CO-CHAIR STETKAR: Okay. And in a couple of them are - one is the methodology to identify break locations. The other one is the methodology to quantify the amount of fiber generated.

In both of them, it says programs other than Casa Grande may be used. Now, these are - these are South Texas specific. They are not - I don't - I don't care what anybody else in the world uses. They can use hand calculations.

It strikes me that the methodology is so integrally related to that Casa Grande quantification scheme that I am curious why, if I used a completely different program at South Texas, why that wouldn't constitute something that the staff would need to review?

MR. HARRISON: Let me - I'll address that by saying when we talk about Casa Grande, Casa Grande has a - you can do the same thing that Casa Grande does with a - if you want to write a different program or do a - if you had some way to do it with a hand calc which might be kind of tedious.

But I just didn't want to hold us to the specific program, Casa Grande. As long as you're doing it with the same fundamental methodology of marching around the pipe and determining the smallest break size. That's the methodology of how you do it, not necessarily the software you use to do it with.

CO-CHAIR STETKAR: I did that and I just didn't -

MR. HARRISON: I think that was put there for our - for our clarity as much as -

CO-CHAIR STETKAR: Okay. Thanks. Go ahead.

MR. HARRISON: That was it. If there are no more questions on the regulatory implementation then I will punt it over to Mike.

MR. MURRAY: So on the conclusions, I want to try to capture the - where we had some questions to follow up also.

So in debris generation what we have discussed is how risk over deterministic process RoverD incorporates the aspects of debris in core effects deterministic as well as risk-informed evaluations. We have - there is a question that we have outstanding and that's the single train flow rate, and we understand that question -

CO-CHAIR STETKAR: It's, in particular, what is the NPSH margin assuming the debris loading that you use across the strainer if a single train was running with full flow from all three pumps.

MR. MURRAY: Do we understand that question?

MR. HARRISON: Yeah.

MR. MURRAY: Okay. And then the other question - another additional question was the difference in the risk results from Supplement 1, Supplement 2. Is that correct?

CO-CHAIR STETKAR: Supplement 2 to Supplement 3 and in particular the so-called case two condition where you have one and only one train running and if I want to focus it down the continuum break part of that where Supplement 3 shows lower values than Supplement 2 and that's contrary to at least my quantitative expectation.

MR. MURRAY: And you had some questions on technical specification mode, Mode 4 to 3 transition, the pressure -

CO-CHAIR STETKAR: Exactly. I want to understand what is the maximum pressure in Mode 4 and do the tech specs allow two trains to be removed from service in Mode 4.

MR. MURRAY: All right. So what I'd like to do with that also is when the staff's finished when we visit make sure that some questions have been addressed from the staff's presentation that we don't follow up. If not, we got them.

CO-CHAIR CORRADINI: Okay.

MR. MURRAY: Thank you. That will close our presentation.

CO-CHAIR CORRADINI: Any other questions from the members of the committee? Because I am going to go into break mode unless -- okay.

Why don't you take a break? We are back at 10:20.

(Whereupon, the above-entitled matter went off the record at 10:07 a.m. and resumed at 10:21 a.m.)

CO-CHAIR CORRADINI: So why don’t we come back to session here. Let’s try to come back into session.

I think we have staff or at least most of the staff. There is only four seats so we have enough for you all. And Lisa, you’re going to kick us off?

MS. REGNER: Yes.

CO-CHAIR CORRADINI: Okay. Go ahead.

MS. REGNER: So we will cover -- I am going to very, very briefly cover basis of review and the staff methodology. I know you’re anxious to continue the technical discussions.

So the regulatory requirements and the primary guidance documents are pretty clear from the SE. We did start to talk about the technical specification change.

Wayne talked about that. I understand there is some questions on the 90-day backstop and we will talk about that in detail very shortly.

I do want to say or emphasize the structure of the staff’s SE uses the five key principles of risk-informed regulation as discussed in Reg Guide 1.174.

This guidance provides an acceptable

method to assess the impact of licensing basis changes using risk and provides consistency in areas where risk is used in regulatory decisions.

And it's a method that compliments the traditional deterministic approach and the NRC's traditional defense in-depth philosophy.

And here is a graphic, obviously, of five key principles of risk-informed regulation. Again, this is how we structured our SE. So the first key principle in white involves regulatory criteria, okay.

CO-CHAIR CORRADINI: I think we have a -

CO-CHAIR STETKAR: Before we get into it, I just want to make a comment. Again, this is a subcommittee meeting so this is only my personal - I found this safety evaluation to be one of the better and more coherent systematic focus on technical detail safety evaluations than I've read in many, many years.

So that's a - it's concise. It focuses on these principles. It's focused primarily on technical issues and it's - and it's presented very well.

So I just - that's my personal opinion. I wanted to get it on the record.

CO-CHAIR CORRADINI: Yeah, and I agree. I found this one just - maybe it's only me but I have a hard time following this after 12 years of this joy and I am even a short timer compared to some of you. So I found this was a very good synopsis on how you guys are thinking how things put together.

I will say, though, since we are on personal opinion, this whole - this whole physical phenomenon is so stylized it concerns me.

That's why I am not sure that I want to make sure it's consistent. I just want to make sure personally that it's systematically bounding because it is quite stylized.

MS. REGNER: Right. And we do look forward to giving you our results. CJ, did you want to make a comment?

MR. FONG: Yeah. I just want to say thanks for the feedback. We appreciate that.

MS. REGNER: Yeah. Yeah. Very much so.

CO-CHAIR STETKAR: And we might disagree about a lot of other stuff but I want to get the good stuff on the record first.

CO-CHAIR CORRADINI: Now back to the -

MS. REGNER: Thank you. That means quite a bit to us. So the regulatory - you know, number one in white meets regulatory criteria unless explicitly related to a requested exemption or rule change. That's straight from the commission's policy. Motherhood and apple pie, I guess you could say.

You'll also - you'll see the key principles two and three, the blue boxes, are the deterministic key principles and Steve Smith will go into detail on those in just a moment.

And we leveraged the staff from the Division of Safety Systems and Engineering for those reviews and, of course, key principles four and five, the tax boxes, are risk expectations and appropriately involve the staff from the Division of Risk Assessment.

And the staff's following presentation reflects the structure of the SE in that we present each criteria and our results. They are not final conclusions but we have reached a point in this review where we have no technical - further technical concerns.

Any questions on the five key principles? Okay. And so getting into the principle one, very quickly, the 50.46 Charlie rulemaking status is with the commission currently.

This - the purpose of that - and I believe you have been briefed on the 50.46 Charlie rulemaking - that would allow licensees wanting to use the risk information to resolve debris and containment without having to ask for exemptions.

These exemptions - and so that's with the commission. It's not completed yet. The rule change would allow licensees on a case by case basis to use risk-informed alternatives, as I said. Let's see, from - and it specified actually in the commission's policy statement that it would be to 10 CFR 50.46 insert and general design criteria in Appendix A of 10 CFR 50.

Let's see. So STP requested four exemptions, as I said, from 50.46 emergency core cooling criteria GDC 35, and Wayne talked about these - 35, 38 and 41 all related specifically to the use of risk analysis versus the staff's traditional deterministic analysis requirement interpretation.

If there are no questions, let's move on and I'd like to introduce Mr. Steve Smith to discuss key principles two and three involving deterministic review.

MR. SMITH: Thanks, Lisa. Yeah, this is Steve Smith and go to the next slide. We will - we are going to look at blocks two, three and four here. This is where the deterministic reviews came in. I am not planning on taking a lot of time on this. It’s been gone over in a previous meeting.

STP talked about a lot of this earlier today. So just ask questions if you see anything that piques your interest. Go on to the next slide.

This just kind of shows where - what we are doing, where we are on the overall process and, of course, we also looked at the three elements on the left side of this figure. So but we are trying to determine if the scenario is deterministically acceptable by doing the things on the left there.

Next slide. We are not - I don’t plan on spending a lot of time on safety margins and defense in depth. We have a pretty detailed writeup in the SE on that. A lot of people had inputs to the safety margin and defense in depth sections of the safety evaluation.

So this just tells, you know, what safety margins are and what defense in depth is, and if you have any detailed questions on what STP did we can - we can get into that based on, you know, question and answer. I wasn’t planning on spending any more time on this.

Okay. Next slide. This is discussing debris source term and similar to other things, STP talked about how they did this. I am just going to quickly go over the differences between how the risk-informed source term for STP was done and how it -- what we are used to seeing done by most plants that have done this deterministically.

So basically most plants do -- they identify one or two breaks that are there, breaks that are going to challenge their strainer the most. What STP did was they -- they looked at every weld on the RCS and they determined how much debris each weld could generate.

They did a test, which we have heard about, and if that weld generated more than that test they basically shrunk the break size down to the point where it did not generate enough debris to exceed the tested amount.

So when they got down to that size that determined the -- that determined the size of the break. Of course, the smaller the break, the more likely it is to happen.

So smaller break increases risk and that's basically how they did it.

CO-CHAIR CORRADINI: So and then I am going to just stop. Bill, I thought you had a question at this point about partial breaks of larger pipes versus double-ended guillotine breaks of smaller pipes. Do you still have that question? Is Bill out there?

MR. SMITH: We can let -

CO-CHAIR CORRADINI: We'll come back to it.

MR. SMITH: We can come back to that.

CO-CHAIR CORRADINI: Keep on. Keep on.

MR. SMITH: Anyway, and they did automate this using a CAD model of containment and a - and the Casa Grande software to do the debris generation and transport evaluation including, you know, all the - all the things that we would look for from a normal - they basically programmed the staff guidance - you know, the rules on the way we do things into the Casa Grande to do their calculations.

The other thing I'll say is that we had Southwest Research and they were extremely helpful to us on this. They did independent calculations. They exercised the Casa Grande software and helped us to look at these things in different ways than we probably would have thought of doing on our own.

So we really appreciate that and we think that by using them we have a, you know, more robust evaluation.

CO-CHAIR CORRADINI: So let me - since John brought this up about with or without the code versus with or without the methodology, did they use the same methodology or did they use the code to do the checking?

MR. SMITH: They did both.

CO-CHAIR CORRADINI: Okay.

MR. SMITH: They came up with their own - in some cases they came up with their own models - you know, simplified models to validate things and then they used the Casa Grande software, you know, and exercised that in many different ways -

CO-CHAIR CORRADINI: Okay.

MR. SMITH: - to make sure that it seemed to work properly.

CO-CHAIR CORRADINI: Okay. Thank you. Bill, I hear clicking. Are you out there? Dr. Shack, this is your last chance.

MR. SHACK: I am muted or I was until I

just turned it back on.

(Laughter.)

CO-CHAIR CORRADINI: Okay. All right. So you - I know you had a question to me. We were discussing, trying to understand things about partial breaks of larger pipes versus equal frequency of smaller breaks double-ended guillotine.

Do you want to ask the question or are you happy now?

MR. SHACK: I am going to wait to talk about that when the staff talks about frequency.

CO-CHAIR CORRADINI: Okay. Fine. Thank you, Bill.

MR. SMITH: Yes, thank you. But the - can we - yes?

CO-CHAIR STETKAR: I have a question about and I don't know where to ask it so I'll ask it now. In the SCR there is a discussion about ultra operating modes and other hazards. It's under initial plant wide screening. And there is a discussion - in particular, I am going to focus on seismic events.

To kind of make it short, there is a discussion that says well, through RAIs, I think, and discussions with the licensee they concluded that seismic-induced - seismic-caused medium LOCAs might be around 10 to the minus 7 per year and large LOCAs would be less frequent, which are well within the criteria.

And indirect LOCAs I think seismic two over one or whatever you want to cause it would be even less likely so that seismic events were screened out.

Two questions on seismic events. What's the frequency of a seismic-induced small LOCA? Because a small LOCA, according to their methodology, will also require a transfer to recirculation because they do not account for cool down and depressurization to get to closed loop residual heat removal cooling before the RWST is drained. They highlight that fact as one of the conservatisms and added margins in their analyses.

So what's the frequency of a seismic landing (phonetic) small LOCA at their plant?

MR. FONG: Hi, Mr. Stetkar. CJ here. I don't recall if they calculated the frequency of a small break LOCA or not.

What they were looking for was a seismic LOCA that could generate and transport an amount of debris in excess of the tested amount.

So I don't know if they tried to quantify that or I'd have to go back and look, or if they just said hey, even if a small LOCA occurs due to a seismic event it can't generate an amount of debris that would fail the strainer, so to speak.

CO-CHAIR STETKAR: Good. That's part of the - part of the answer, perhaps. Part 2 of the question is how do they account for seismic events that may create amounts of debris that are larger than the amounts of latent debris that they assumed in their strainer testing?

And what I am talking about is a seismic event that dislodges a whole bunch of dirt, particles, fines, chunks of stuff from places in the containment which then fall down into the containment sump that add effectively to the latent debris loading that they assumed?

So now I am talking about a small - where I am going is a seismic event that can cause a small LOCA and create much more debris in the sump than what they used in their testing.

Now, I'll grant you they will never be able to quantify that additional amount of debris. So this may be a frequency argument.

But I don't see compelling arguments about why seismic-induced small LOCAs with perhaps larger quantities of I'll just call it stuff is beyond the zone of influence - it has nothing to do with whatever the pipe break itself might create.

MR. FONG: I understand the question. I think that actually came up on a previous ACRS meeting.

CO-CHAIR STETKAR: On a - it was a different licensee. It wasn't on this. But it's a continuing thing.

MR. SMITH: Yeah. So what we would expect is - I agree, with a seismic event you could have a lot more particulate type debris. I don't expect that you would have any additional fibrous debris generated.

They are basing their evaluation on fibrous debris and we did look at - when we did the evaluation we did look at what would happen if there was more particulate or, you know, we looked at the results of the test basically and we said when they got to the end of their chemical effects test it didn't matter what else they were going to put in there.

They weren't going to get a lot more head loss because it was limited by the amount of fiber in the test. So we did look at the particulate to fiber ratio. I think we addressed that in the SE, not in specifics.

CO-CHAIR STETKAR: But, again, the amount that they used in their test was based on the amount they could generate from, I don't remember, it was two or three - what they characterized as bounding locations.

MR. FONG: That's fine, yes.

CO-CHAIR STETKAR: So the amount of particulates that they used in their test.

MR. SMITH: And it might not - that amount of particulates may not have been bounded for a seismic event.

CO-CHAIR STETKAR: Seismic event.

MR. SMITH: I will agree with that. But we don't think that that would have a large effect on head loss if you got a lot more particulate in the debris bed with a given amount of fiber.

CO-CHAIR STETKAR: Okay. Okay.

CO-CHAIR CORRADINI: Remind me what the

ratio was of fiber to particulate in the 192, or --

MR. SMITH: It was - it was pretty high. I don't know exactly how much was in the test but it was a pretty high particulate to fiber ratio.

CO-CHAIR STETKAR: I don't think it's published anywhere because this -

MR. SMITH: The other - we'd have to go back to the test report and look, I think.

CO-CHAIR CORRADINI: But my impression was - I didn't review this for - because my impression was they did various combinations and they looked for the worst of the various combinations of the ratios. That's what my memory is.

CO-CHAIR STETKAR: No. No. They generated an amount of particulate based on - you probably remember this - it was two or three breaks that they looked.

They ran Casa Grande basically and found the two or three breaks that maximized the amount of particulate debris and they weren't - if I recall, you got more of one type from one break. You got more of a different type from a different break. They added those together, which you can't get because you can't have the two breaks simultaneously. But they did that to generate the amount of particulate that they then used in the strainer test.

MR. SMITH: The sensitivities -

CO-CHAIR STETKAR: So it wasn't - yeah.

MR. SMITH: You're thinking of around fuel testing.

CO-CHAIR STETKAR: Right.

CO-CHAIR CORRADINI: Okay. Excuse me.

CO-CHAIR STETKAR: This was for the strainer head loss though for the test. It was just the maximum that they could generate from the Casa Grande results for, you know, running around the system looking at it.

MR. SMITH: Right.

CO-CHAIR CORRADINI: Go ahead.

MR. SMITH: Okay. So we can hopefully go to the next slide and this is talking about debris transport and I am not going to - the debris transport we've talked about to the strainer before.

We haven't said much about the debris transport for in-vessel. So that's what I want to concentrate on this slide.

We only evaluated the debris transport for this part of the evaluation for the cold-leg break.

The hot-leg break is going to be talked about by Josh. That was the thermal hydraulic analysis.

For the cold-leg break, in order to determine how much fiber might get to the core, they did testing and they varied the flow velocity, the debris concentration.

They looked at sensitivity. In the final testing they didn't look at water chemistry but they did some sensitivities previously on water chemistry and some other things.

So they used conservative values from this fiber penetration testing to determine how much fiber might get through the strainer and then they used those values to determine how much - once this fiber gets through the strainer where is it going to go in the system - how much is going to get to the core.

So that all depends on how many pumps are running, you know, which pumps are running, things like that.

So what - the bottom line is the fewer pumps that are running the more fiber is going to get to the core and look for a cold-leg break for this design plant because if you have a lot more flow into the core most of the - most of the flow is actually going out the break and a lot of the fiber is going to carry out with that.

So the fewer pumps you have running or the less flow you have going into the core the more of that debris is actually going to go to the core inlet and actually block it.

If it doesn't, if goes out the break. It comes back and it has a chance to filter by the strainer again.

So they did some - they did a lot of different cases and under normal design basis cases they would end up with about two grams per fuel assembly of fiber in the core, which is much lower than what we evaluated for 16793 - WCAP 16793, which had a 15 gram limit for the hot-leg break and we knew that, like, much less would get in for a cold-leg break than 15 grams.

So we know that they can get adequate cooling. We had questions about boric acid precipitation. I guess - I guess that's a feature - that's a slide coming up that I should talk about later.

But anyway, this is how they determine how much fiber will get to the core for a cold-leg break and we, again, had Southwest do some independent - they came up with their own models for this to make sure that they were modeling this correctly.

All right. The next slide - impact of debris on the strainer. I know you guys are waiting for my next slide so I won't take too much time on this one.

This we have talked about what I think the main thing to take out of this is that when they evaluated the effects of the debris on the strainer, they evaluated them at the head loss that was attained after chemicals were put into the test.

So, basically, they took the maximum head loss for this particular debris load and this, you know, plant condition, this flow rate and they evaluated the strainer for NPSH margin, structural margin, flashing, degradation, and vortexing.

They used staff approved methods to do all these evaluations at the - at the tested debris head load. ACRS had previously questioned why the head loss - we discussed the two tests before.

The first test that was done the head loss got so high they couldn't even put chemicals in the test because the head loss was so high. The second test that was done at the - at the smaller debris load was significantly less.

So if we go to the next slide we can see these are - now, these are - these are not how they did their calculations for - to determine how much debris would come from each pipe.

These are all double-ended guillotine breaks. So you can see that the 200-pound line - basically, all the dots below that pass. They are all less than the tested amount. Everything above that - you can see the one dot right at the 150. That is the - that's the pressurizer surge line break that failed.

All the other breaks above there are large looped piping breaks. So that's where your majority of your debris comes from.

So, basically, if you look at the top you have almost 800 pounds of fine. That's what they did the first test with. The second test was done with less than a quarter of that amount of debris and that's why - that's why the head loss is so much less.

So you might just want to think about this. I'll also say that Osvaldo from Southwest pointed out to me there is a couple of red dots that are 29-inch breaks and some green dots in the lower right that are 27.5-inch breaks. Those breaks are inside the reactor - inside the reactor cavity. So they can't generate a lot of debris. They just - you know, there is a big concrete wall there and the jet's not going to get out and damage all the stuff.

CO-CHAIR CORRADINI: I should remember this but I don't so I'll admit it. So just to go back to the one you guys are circling, the one that was - that was failed a low fiber load was the pressurizer surge line?

MR. SMITH: That - yes.

CO-CHAIR CORRADINI: Okay.

MR. SMITH: That's the one that - if you do all the single and all the - all the single or directional breaks or partial breaks resulted in less than 192 pounds or 191 pounds of fiber so then when you go to the double-ended guillotine break it shows up with 200 and some pounds.

So there is, like, a discontinuity there in the way that the generation - because it doubles the size of the ZOI when you go to a double-ended break, basically.

Okay. Is that - is that good? Okay. I am ready for the next slide. This is my - this is my last slide so get your questions ready.

This is talking about the cold-leg break - the impact of the debris so for in-vessel. We talked about a couple slides ago the amount of debris reaching the core for a cold-leg break is much lower than the amounts shown to be acceptable for cooling by the WCAP 16793.

The one thing that 16793 did not do was evaluate anything about boric acid precipitation because the concern was there was no testing done to say okay, if you get debris at the core inlet this could block communication between the core and the lower plenum and most plants credit the lower plenum as a volume to dilute the boric acid that's in the core.

So we don't think that 2 grams or 3 grams is going to affect that communication. But we don't have anything definitive to tell us that now. I mean, we have some - we have since done some work with research and trace and we don't think it would be an issue. But we'd have to come to any firm regulatory conclusion on that.

CO-CHAIR CORRADINI: So you may - you mentioned the magic word. So I am curious, did the staff or research do any trace calculations to audit the RELAP-3D calculations at all?

MR. SMITH: I'll let Josh talk about that. I don't think they did the B

MR. KAIZER: They did actually.

MR. SMITH: Oh, they did? Okay, good.

CO-CHAIR CORRADINI: Okay, so, whenever it's appropriate, I'd be very curious because I guess I'm not concerned about this, but if you said you have no basis other than judgment, that two, four or seven is okay B

MR. SMITH: Right.

CO-CHAIR CORRADINI: -- there's nothing more than judgment? There was no calculation that showed that you get enough mixing for boric acid precipitation?

MR. SMITH: Yes, so, they only B

CO-CHAIR CORRADINI: Well, this or B

MR. SMITH: -- did the hot leg break.

CO-CHAIR CORRADINI: -- this or other analyses. I was going to ask about the hot leg when the time is right. But, here, this is based on hand calculations? What is it based on?

MR. SMITH: This is based on the B

CO-CHAIR CORRADINI: That it just doesn't B that it simply doesn't block, therefore, there's good communication.

MR. SMITH: This is based on the staff's judgment that a very small amount of fiber would not inhibit communication between the lower plenum and the core.

Now, we are not B this has been an ongoing B and we might have to get Reed up here to talk about it B but this has been an ongoing discussion as far as, you know, how boric acid precipitation calculations are done for a long time.

No one, I don't think any PWR has resolved this issue with the staff to say that, you know, we don't have a boric acid precipitation issue. We have closed out Option 1 plants, these are the basically the clean plants.

Deterministically, they still have to come back and address boric acid. So, we're leaving STP in the same boat. What we're saying is, we don't B our judgment is that it's not a big enough problem that we have to deal with it today but it needs to be addressed eventually.

CO-CHAIR CORRADINI: Okay.

MR. SMITH: And, that's what our SE says, you know, we're not going to say it's okay for you, you've got to come back and show us later.

And, the industry B the PWR Owners Group is working on that.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: I did want to add that the Office of Research, under Dr. Steve Bajorek did a lot work and I think he even published a paper on trace analysis of the cold leg break.

And, it's B you block B I think you block 99 percent of the core. In one case, you can block a 100 percent of the core and they B trace I think is one of the few codes that actually has the ability to track one. And, there's so much mixing in the core and you don't need that much liquid to go through that nothing seemed to occur.

CO-CHAIR CORRADINI: But COBRA B since we're just talking about actually useful interesting stuff B

(LAUGHTER)

CO-CHAIR CORRADINI: COBRA with the subchannel you should be able to do this, too. So, I would think there is a number of tools at least you can do some sensitivities to see if this is even doable.

So, it traces one, but it’s more of a single channel versus COBRA in the subchannel mode that you can look at this sort of mixing.

MR. KAIZER: But our intent of that trace analysis wasn’t, like Steve said, to close out the issue was just to give us a sense of, okay, is it okay to say we can treat this through a later topical B

CO-CHAIR CORRADINI: Okay, yes, okay. All right, thank you. Thank you very much.

MR. SMITH: And, I believe that it’s time for me to turn it over to Josh for the in-vessel hot leg break presentation.

MS. KAIZER: Joshua Kaizer, I’m a Nuclear Performance and Code Review Branch. I wrote the Safety Evaluation, so it’s actually the appendix to the main safety evaluation along with my coworker, Reed Anzalone.

The presentation I’m about to give is a high level summary of the safety evaluation. So, I don’t want to make anybody feel like they’re missing anything. I didn’t intend to go through all the details, just do a high level summary.

If you don't remember a lot of what happened before in vessel thermal hydraulics, that's absolutely fine.

I started this project in October 2015 and really, since then, it's been a clean slate. So, a lot of what was given in the previous supplements for thermal hydraulics, because it is a pilot program, we went over it. And, a lot of it, we just said, okay, that's not working, let's try something else.

So, it's captured in the safety evaluation and in the RAIs since then.

We've had multiple audits with South Texas and Texas A&M. They have been extremely supportive and extremely knowledgeable.

I think you mentioned earlier, Dr. Corradini, Reed and I were very concerned about how this would seem as generic approval not only for RELAP5-3D, but potentially for any other licensee that would want to go forward using this same approach.

South Texas had a lot of unique things to their plant that made us be able to say, you know, we believe this is a very strong case to say what we can say here.

I don't know that those things are true

for all other plants. So, we were very careful in the safety evaluation and in the conclusions of the safety evaluation to say, this is the box of approval. For them, it's fine, for anyone else, you have to come back and ask the NRC.

And, even if STP wants to go off and make major changes, they'd still probably have to come back and say, hey, NRC, can we do this? Because we didn't want to get into all the caveats of, well, you can do this but not do that.

So, we just said, hey look, what you guys gave us is fine, anything else, come back and talk.

The last thing I'll say is, even though this was a B this was B there was a time challenge here. I received really good support from not only my project management but also my senior management.

At the end of the day, it was okay, do you need more information or do you feel like you can complete your safety case? And it was our decision and we said, no, we feel like we don't need to ask anymore RAIs. We think that they have given us enough information.

So, with that, our main goal in this was to determine if the long-term core cooling model that they provided, which was RELAP5-3D and how they used it gave credible results for this situation.

And, this was a challenge because of validation. The first question is how much validation do you need to justify it? The next question is how much validation, i.e., data, do you actually have?

And, to be honest, you B no one really studies this area. You're not going to go out and find a ROSA case where they've actually done this long-term core cooling.

So, next slide?

The solution we eventually came to, and this was really interesting to me, I've never thought of it before and I talked with a number of other engineers in my branch to say, hey, does this make sense, is, instead of doing the normal conservative thing where, if you're not sure if the answer is three or five, you say it's seven.

We reduced the complexity of the model. And, the idea behind this is this statement, and I guess it's more philosophical, the amount of elevation is proportional to the complexity of the model. If you reduce the complexity of the evaluation model, you reduce the amount of validation you need and you do it in a conservative way.

If you can take turbulence out of any analysis, you don't need a lot more validation because turbulence is the thing that usually makes everything really difficult.

And we tried to apply that here. The way we, obviously, and I'd say directly applied it was, when we took the large hot leg break and we said, you know, we don't want to analyze those. South Texas, we met with South Texas, Dr. Bajorek was there. The people from STP were there.

We were seeing how the B so we met at a Texas A&M, South Texas was there.

And, we were looking at the results of the large hot leg break and things didn't make sense to us and it wasn't sure if it was, well, was it a modeling error? Was it a coding issue? Was it because people usually don't look at hot leg breaks?

And, it got to the point where we said, well, is it really worthwhile trying to resolve this? Or, can we just say, you know what? This phenomena gets a little bit too complex, do you really need to model these breaks?

And, the answer came down to, well, no, we don't need to model these breaks. We can treat them as risk informed.

So, they took those break. They assumed that they went to failure. In all likelihood, I do believe they probably wouldn't go to failure, mostly because they, and I'll get to this in the initial assumption, they assumed that the entire bottom of the core is blocked.

And, in all likelihood, you're not going to block, and I say this in the SE, the barrel-baffle region. So, you're still going to have flow that flows into the barrel-baffle region and there's even flow holes connecting the barrel-baffle region to the core. But, if you don't want to buy those flow holes, it's going to flow up into the top of the core and flow down.

So, you're still going to get flow in there.

CO-CHAIR CORRADINI: But, in all the analyses, that all was ignored?

MR. KAIZER: That was ignored except for in one sensitivity study that South Texas did where they kept the barrel-baffle region open just to confirm that, yes, as you dump water on the core, nothing interesting happens and the temperature stays constant.

So, the first one was that.

Another major area, we did not want to give the impression that the NRC's approving RELAP5-3D. Moreover, we didn't want to have to review RELAP5-3D for all the areas occurring the blow down refill reflow region since, again, those are the complex phenomena.

So, we said, okay, let's just review RELAP5-3D and those areas to make sure that they give us what we think are reasonable results for the beginning of the long-term period.

This way, if it's getting its blow down heat transfer completely wrong, I don't really care because it's going to B it might miss the peak clad temperature, but the peak clad temperature isn't important to me in this case. The initial peak clad temperature because I'm looking at this analysis after the core is quenched.

And so, then, you kind of just look at, okay, do these input B did the initial conditions for that Phase IV, do they make sense?

And, that was one of the other ways that we tried to reduce the complexity and also try not to give need to do a very long review because, if you do a review on RELAP5-3D, I mean, that’s at least a two year review in and of itself.

So, next slide, please?

CO-CHAIR CORRADINI: So, then, back to the B a question. So, now, we’re back into B we’re into hot leg now?

MR. KAIZER: Yes.

CO-CHAIR CORRADINI: Good. So, this is where you did do trace calculations?

MR. KAIZER: We had B

CO-CHAIR CORRADINI: Because I was looking for them, particularly for boric acid, right.

MR. KAIZER: And so, trace calculations done for boric acid precipitation for a cold leg break. We asked, and this was B I was talking with Tarek and it was literally a more B not really last minute, but it was unofficial, said, hey Tarek, can you find a four-loop PWR, run an analysis to make sure that we’re seeing about the same results we’re seeing in South Texas.

They didn’t take the South Texas input. I think the plant, they actually used as Seabrook. They did flow blockage, they ran a PCT calculation, things looked about the same.

That was the one analysis that we did. And that was more toward the end.

The other thing I should add is, because we kept B this was a pilot program and we were seemingly modifying the approach or working with STP and they were modifying their approach to the analysis that they actually wanted to give us.

Like this B we stopped looking at large breaks which we're defining as greater than 16 inches I think in February or March of 2016. So, before that, we were trying to consider large breaks. So, that's why I'm saying this was a definitely a moving B what's a good word?

MS. REGNER: Target?

MR. KAIZER: Moving target. We were moving B we're changing our philosophy.

CO-CHAIR CORRADINI: Okay. So, but then, just to summarize, so you didn't do trace audit calculations for the small and medium?

MR. KAIZER: Correct, that's correct.

CO-CHAIR CORRADINI: Okay. And, you did some calculation to give you a warm feeling, but it wasn't applicable as you see it?

MR. KAIZER: It wouldn't have been one to one, correct.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: And, part of B

CO-CHAIR CORRADINI: So, what did you do with RELAP3 or make STP and their contractors do to give you a warm and fuzzy that a variety of initial conditions weren't that big of a deal for Phase IV?

MR. KAIZER: Mostly what we B I'm trying to think about this the right way.

It was mostly through the audits and then through the sensitivity studies that they did perform.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: So, we tried to stress the analysis in every way we could with the sensitivity studies to really see, okay, am I impacting these results?

CO-CHAIR CORRADINI: Okay. Because when I looked at the South Texas submittals and I think I have the right RAIs, I'm never sure, I couldn't find a calculation that showed a large increase anywhere near 800F. It was all B

MR. KAIZER: Yes.

CO-CHAIR CORRADINI: -- essentially saturated conditions at the given pressure.

MR. KAIZER: And, that was one of the main things that was really driving us to say, we couldn't make any small tweaks to make anything go off, to make anything worse. And, everything seemed very stable and that was B gave us a high degree of confidence that this B there's a good safety case here.

CO-CHAIR CORRADINI: So, I had one other question but maybe you want to postpone it.

So, I'm interested about timing. You took 360 seconds as a binary unplugged plug?

MR. KAIZER: Yes.

CO-CHAIR CORRADINI: And, then, you did consider B you did allow them to consider upper plenum nozzle something or other spill over.

But, yet, in their RAI, they showed calculations with and without it, unless I misunderstood what I was reading. And, it was really just the plumbing. It wasn't the presence of the upper plenum nozzles.

MR. KAIZER: So B

CO-CHAIR CORRADINI: So, you're going to come to that?

MR. ANZALONE: Well, we can talk about it now.

CO-CHAIR CORRADINI: No, that’s all right, if you’re going to come to it, that’s B

MR. ANZALONE: Well, I think it makes sense to talk about it now because it relates directly to the risk informing the large hot leg breaks.

CO-CHAIR CORRADINI: Okay, fine.

MR. ANZALONE: It was more important to consider the phenomena related to the upper head cooling nozzles and the flow that goes down through the control rod guide tubes when they were considering the large hot leg breaks --

CO-CHAIR CORRADINI: Oh.

MR. ANZALONE: -- in the deterministic analysis.

CO-CHAIR CORRADINI: So, they B if you allow a binary failure there and you just simply risk inform it and add it to the numerator versus the denominator, you can even ignore upper plenum nozzles?

MR. ANZALONE: Yes, basically. They still modeled them but they had very little impact on the results.

MR. KAIZER: A large part of B I think it was like four or five hours of an eight hour discussion was directed when we were at Texas A&M to what's going on there? How much can we credit it?

MR. ANZALONE: Yes, how they modeled it.

MR. KAIZER: The modeling.

MR. ANZALONE: The upper head.

MR. KAIZER: Yes, and that was just like, okay, guys, can we do this another way?

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: So, that's what B so that actually leads really well into this slide where we're looking B we focused on hot leg small break and medium break. We're defining medium as less than 16 inches.

The large break, more than 16 inches we said was risk informed. And, then, as Steve said earlier, all the cold leg breaks were just considered we're over the risk.

One of the first challenges was trying to come up with criteria for success for long term core cooling because it's not in 10 CFR. We chose the criteria that was in WCAP-16793 which means the max PCT of 800 degrees Fahrenheit and should be a deposit thickness of less than .05 inches.

CO-CHAIR CORRADINI: So, help me with

number two. Okay? Help me with number two, that's the distance between rod to rod closest approach for that B the diameter?

MR. KAIZER: The deposit thickness as I understood it, and this was B it was kind of like a footnote in 16793, but it was the amount of debris that is deposited on the rod. They B like you wanted to make sure that B

MR. ANZALONE: Because they didn't want to close the gap between the rods.

CO-CHAIR CORRADINI: So, this one, I maybe missed in my reading where this was. Is this not bounding compared to number one? Because I didn't see analysis that actually tried to track where this deposit is.

MR. KAIZER: The deposit was a separate B the deposit thickness was actually the generic analysis and South Texas can correct me if I'm wrong. It was performed by Westinghouse and I believe they were using the LOCA DM model and they B

CO-CHAIR CORRADINI: What? I'm sorry.

MR. KAIZER: A LOCA DM. I don't remember what the DM stands for.

CO-CHAIR CORRADINI: Okay.

MR. ANZALONE: Deposition model.

MR. KAIZER: Okay, the LOCA deposition model.

And, they B actually, I get to it in my next slide.

CO-CHAIR CORRADINI: That's fine, okay.

MR. KAIZER: So, I'll go back for a minute because I want to show something else.

Okay, the thing I wanted to point out about, before I get to the deposit thickness, max PCT is less than 800 degrees F. That's where the long-term core cooling evaluation model was focused. That's where we spent the vast majority of the safety evaluation. We used Standard Review Plan 1502 to kind of guide us. That's what set my framework.

Even though the max PCT was above 800 degrees F, our sub-criteria, and this was just which to make life easier is, if temperatures never really got above saturation. Because if you don't get above saturation, you don't get into all the fun two-phase B extra two-phase flow phenomena. That's where the real complexity and uncertainty lies.

So, thankfully, we could fairly well maintain that.

All right, next slide.

All right, so, this was B

MR. SHACK: I just have a quick question about the cold leg, the RoverD. This is risk informed, didn't you just do the deterministic calculation and then met the PWR Owners Group 15 grams per fuel at that point.

MR. KAIZER: I'm sorry.

MR. ANZALONE: Yes, that's right.

MR. KAIZER: Yes, it was deterministic.

CO-CHAIR CORRADINI: It's just, they basically B I think, Bill, the way I B I was confused, too. But, when they say this and basically show that I'm less than 15 so they pump back to the main SE. They don't consider it in this SE.

MR. SHACK: Yes, but there was a word in there that it was done by risk and risk never entered into the cold leg blockage.

CO-CHAIR CORRADINI: I changed my version of that table, so I didn't forget, but you're right. It's not risk.

Bill, did you have another question?

MR. SHACK: No.

MR. KAIZER: So, the first criteria, the

maximum deposit thickness, the LOCA DM analysis was performed. They assumed 91 grams per fuel assembly which was an extremely large amount.

And, they also assumed that all of this amount of fiber bypassed the strainer. It reached the core. It dissolved and the total deposit thickness was still well under the .05 limit.

I should also add that you would never have this much reach the core. And, I believe that it's not even physically possible to have that much debris in the reactor itself. Because I think the maximum STP you can have is like 51.

CO-CHAIR CORRADINI: So, since we were supposed to remember this was in 16793 and I don't, what's the physics that allowed that stuff to get deposited? Just physical, mechanical pick up at the grid spacers?

Because I was reading that part of the SE and the STP analysis and they go through some sort of discussion and then it just kind of stops. So, it is mechanical pick up of it as if it were essentially just picking up fibers and associated junk or what?

I was trying to understand the physics of this DM because I don't remember.

MR. SMITH: I think we might have to phone a friend here. Paul's coming up to the microphone.

The LOCA B the 16793, it did two things, it assumed that all the grids were just clogged with debris and it showed that you could get radial heat transfer.

But then, the deposition, I'll let Paul talk about that part.

MR. KLEIN: This is Paul Klein from NRR.

The LOCA DM model assumes all the fiber dissolves and then it uses that source term in addition to the other dissolved species and it arrives at a boiling rod surface and deposits via that mechanism like a scale deposit.

So, it's really not capture of any fibers at all within the core considered within LOCA DM, it's more that that fiber into the core just adds to the chemical source term, if you will.

CO-CHAIR CORRADINI: So, help me out, what experiments show that the LOCA DM model is right or at least bounding for scale build up? Since I B this is an area I don't remember.

MR. KLEIN: Back within the SE that we wrote for WCAP-16793, they had done some benchmarking.

A LOCA DM with some boiling surfaces and tried to see if the measured scale that was present in those experiments was bounded by LOCA DM.

CO-CHAIR CORRADINI: Okay, okay. All right, I'll just have to go back to that SE. Thank you.

MR. KAIZER: Next slide?

All right, next I wanted to walk through what the transient looked like. So, if you guys can get an idea in your mind.

So, again, this is long-term cooling. You're having the water being injected into the cold leg flows. And this is before the blockage for long-term. The core is covered. It's pretty much flowing out the core and it's also partially filling up the steam generators.

Next slide?

You have debris blockage instantaneously.

Next slide?

And so, what's happening is the core water is now flowing B trying to flow into or in the cold leg down to the down comer to the bottom, can't flow there, has to go out through the other way. So, it fills up the steam generators and flows down the hot leg and then out the break of the hot leg.

And, it's the water that's flowing into the hot leg, into the upper plenum that's sitting on top of the core. That's providing your cooling to the core.

CO-CHAIR CORRADINI: So, if you had your B because you're fancy with your cartoons, if you put in another little circle, that means the hot leg that went to the right comes back magically.

MR. ANZALONE: Yes.

CO-CHAIR CORRADINI: What I'm trying to understand is, what made the RELAP model simplified enough that you bought off on it for this specific use besides the initial conditions?

Was it essentially just minimizing the complexity of the upper plenum region to essentially a volume and just looking at it and using the CCFL limit?

Was it strictly the CCR B

MR. ANZALONE: We're going to get into that over the B

CO-CHAIR CORRADINI: Okay.

MR. ANZALONE: -- over the next few slides.

CO-CHAIR CORRADINI: But, yes.

MR. KAIZER: So, yes, very good question, I'll make sure we answer it by the time we're done.

CO-CHAIR CORRADINI: Okay, fine.

MR. KAIZER: Because it is a coming up.

So, all right, cool. So, now we get to the actual structure of the safety evaluation.

The first thing was the accident scenario identification process, STP, through Texas A&M performed a PERT.

And, for the long-term core cooling, the two phenomena that were most important were boiling in the core and countercurrent flow limitation.

The B and we also looked at the initial boundary condition. The stuff that's highlighted in blue are the initial B and throughout this document and it's in bold B those are the areas where we believe there was significant conservatism.

The first one was core bypass flow. STP had a lot of core bypass flow they could have used. They ignored pretty much all of it.

The time to blockage, assuming 360 seconds for a blockage was very conservative. It is the amount of time it takes to transport 15 grams per fuel assembly from the sump into the RCS. So, it's not necessarily into the core region, but into the RCS.

And, also, the testing shows that not that the core will block at 15 grams per fuel assembly, but that the core will not block at 15 grams per fuel assembly.

CO-CHAIR CORRADINI: Say that again?

MR. KAIZER: The testing that they performed showed that the 15 grams per fuel assembly is not the amount of fiber it takes to block the core, but that, if your core is sitting at 15 grams per fuel assembly, your core is not going to be blocked. There's still going to be adequate water flow.

So, we chose that as a lower bound.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: In reality, the amount of core fiber you would need is a much higher number.

CO-CHAIR CORRADINI: Much or not higher?

MR. KAIZER: High, yes, sorry, good point.

CO-CHAIR CORRADINI: And then the 360, li want to make sure I get the timing, 360 is I have injection from the RWST. I run out of water. I go into re-CIRC and it's 360 seconds after the mode into re-certs?

MR. ANZALONE: Correct.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: As soon as you start pulling from the sump.

CO-CHAIR CORRADINI: Okay.

MR. KAIZER: And, then the other input boundary condition they had that was conservative like Ernie was talking about was the subcooling where they were using very little sub-cooling. So very hot water so you'd boil it faster.

MR. ANZALONE: And they didn't account for sump cooling.

MR. KAIZER: Yes.

CO-CHAIR CORRADINI: So, you're not C. J. Fong anymore.

MR. ANZALONE: No, Reed Anzalone.

CO-CHAIR CORRADINI: Okay, because you don't have a name tag and our reporter will B

MR. ANZALONE: I will check with him afterwards.

CO-CHAIR CORRADINI: I find these intelligent comments to Mr. Fong.

(LAUGHTER)

MEMBER REMPE: So, while you're here, though, could you discuss a little bit about the location of the break --

MR. KAIZER: Sure, yes.

MEMBER REMPE: -- that was assumed and how you were happy with that assumption?

MR. KAIZER: I have that on the next sensitivity but I'll B

MEMBER REMPE: Oh, okay, you can wait, that's fine.

MR. KAIZER: Okay.

The other case, so we talked about why early blockage is conservative. The other thing that we were very key on making sure happened was doing a break size sensitivity because the last time we assumed that a smaller break was always going to be conservatively bounding for a larger one, that I'm aware, well, we did it a lot in TMI and didn't think that was a good idea.

So, we had South Texas do a sensitivity to show us, okay, is the small break size actually bounded by the larger break size?

And, it is, but things get interesting there. And, the reason things get interesting is because, if you use PCT as your figure of merit, it looks like a smaller break size is worse because it has a higher PCT.

But, that's only because you're maintaining your pressure. So, you're actually, you're still sitting at saturation, it's just you're at a higher pressure, so you had a higher saturation which is why, in the SE, we tried to, I believe we say that the better figure of merit to determine the most limiting break is the level.

And that's the B in the larger break, you're closer to reducing your two phase levels, so we said that was the most limiting break.

Documentation, the RELAP5-3D manuals and I think the most important thing from this is that the evaluation model itself is captured in the RAI responses from South Texas and not in the previous supplements.

Because a lot of that B what's been put in the previous supplements has been superseded by what they gave us in the RAI responses.

CO-CHAIR CORRADINI: So, even though this is a specific calculation versus the generic calculation is acceptable, the methodology is such that if one were to come back later one with not RELAP, but computer calculation X and went through this, this would be a starting point to understand how this would be effective considered?

Because what I guess I'm thinking about is we've had a number of meetings on 15 grams being the ultimate dividing line. I can't come up with a better word.

And, this basically how it's not for a particular plant for a particular set of conditions. And this leads me to ask, well, then, maybe this is a logical way out for a number of plants in terms of how the plumbing, actually, you have to consider the overall system plumbing that would give you a possibility of allowing for a conservative conditions, core bypass flow tied to full blocking, subcooling and loading and still be acceptable.

That's what I interpret this to mean.

MR. KAIZER: Well, and B go ahead, Steve.

MR. SMITH: I was just going to say, we're currently working with the PWR Owners Group on another topical report, another WCAP, to increase the allowable in core debris loading. And, it is much more complex than 16793 was.

But, it accounts for these various flow paths. I don't believe they account for flow over the steam generator tubes, but they're looking at flow paths internal to the reactor. You know, the load holes, things like that.

CO-CHAIR CORRADINI: Okay.

MR. SMITH: Bypass, flow pass.

So, that is being done. They're using RELAP5, not 3D and they're using COBRA tracking.

CO-CHAIR CORRADINI: Okay, fine. I just wanted to make sure because it's the B to me, it's not a matter of the computer program as much as the methodology of what was considered and how the system interacts.

MR. ANZALONE: Though, I do think that we need to caution a little bit that that would potentially vary depending on the plant design.

CO-CHAIR CORRADINI: Yes, yes. I mean the geometry B the specifics would matter. I agree with you.

MR. ANZALONE: Yes.

CO-CHAIR CORRADINI: No, I didn't mean to say that it was generically acceptable, I just meant to say that at least there's a path forward to look at it.

MR. ANZALONE: At least it's feasible to

take an approach similar to this.

MR. KAIZER: Yes, I think for B in a lot of cases, it will be very challenging. I mean, when you look at the RELAP series, you do assign some fact that it is well known used, widely used and credible. It's not just, hey, Josh came up with his own LOCA code.

And, so, you try to give it some credence there, but, yes, it B that's one of the things that we really struggled with in this SE.

CO-CHAIR CORRADINI: That's fine.

MR. KAIZER: And that's the conservative nature of it.

CO-CHAIR CORRADINI: Just for my own clarification, remind me, RELAP5-3D versus RELAP5, what's the difference that makes one blessed and the other one not blessed?

MR. KAIZER: So, RELAP B actually, RELAP5 isn't blessed. The only one that's blessed that I'm aware of is SRELAP5 which was the evaluation model that AREVA sends.

MR. ANZALONE: Yes, because RELAP5 is the staff's code.

CO-CHAIR CORRADINI: So what does NRR use if they do an audit calculation?

MR. KAIZER: NRR typically uses trace. Len Ward used to use RELAP5 and I B but I don’t remember which mod he used.

CO-CHAIR CORRADINI: So, NRR does not use RELAP5? Gee, that doesn’t sound right to me.

MR. KAIZER: I do not know.

CO-CHAIR CORRADINI: Okay, fine, that’s a fair answer.

Okay, let’s keep on going.

MR. KAIZER: All right, next slide?

Okay, so, for the evaluation model development, and again, the major section, the site review plan, we focused heavily on the closure relations.

One of the things done with Chen (phonetic), we said, okay, that’s the standard model for boiling, we were happy with that.

The CCFL treatment, that was B that took a little bit longer time to get through because that could be very important.

And, we went and we looked at how they treated the CCFL model.

I just wanted to correct something earlier and I don’t know if you said that they used the most conservative one, of the three they looked at, they didn't use the most conservative because, generally, the most conservative CCFL model is the one that's developed for like a single tube.

They used one that was developed for multiple tubs, but then there was one that was even least less B

CO-CHAIR CORRADINI: They used Wallis and not Bankoff?

MR. KAIZER: Yes, but there's two Wallis, there's like smooth B

CO-CHAIR CORRADINI: Square and smooth.

MR. ANZALONE: They use smooth Wallis.

MR. KAIZER: Yes. And, when we looked into that and also saw how they were treating that with just the radial noding, they were treating the core as a single radial node.

If you treated the core as multiple radial nodes, you would B it made sense to us that you wouldn't see CCFL in every channel. You would have some hot assemblies where you would have steaming, but you'd have other cold assemblies where you wouldn't, so you'd have even better mixing.

And, they performed a single sensitivity where they only just average core hot channel and because of that, you even saw a slight dip in the B I think the peak clad temperature. Now, I'm trying to think on that slide.

CO-CHAIR CORRADINI: But in this case, so with the CCFL, RELAP is like TRACE, there's no intercommunication between what I chose to be a channel. So, any one of the channels has to behave independently.

Whereas, in reality, in the PWR open lattice core, you'd have a lot of crosstalk. So, that was not considered in these calculations.

MR. KAIZER: That was not considered and that was one of the major conservatisms we saw in their treatment of CCFL.

CO-CHAIR CORRADINI: Okay, okay.

MR. KAIZER: The next part in the SRP was a code assessment, the validation of the evaluation model which I'm going to save to my conclusion because I think that's the main part and main objective of our safety evaluation and how the sensitivity studies.

The first one I will mention is break orientation. We did access if they had done a sensitivity on break orientation. They had done one earlier. They provided the response in an RAI and they did say that there was no effect on break orientation and the peak clad temperature when you're looking at this long-term portion of the event.

MR. ANZALONE: It just slightly changes the elevation if the water sits in it.

MEMBER REMPE: Right. It seems like we've seen in other examples where it would drain down faster if it were located at a certain position and they didn't provide B

MR. KAIZER: Well, it would drain down faster in the initial part, but when you're in the long-term part, you're kind of just maintaining that level. So, I mean, either I'm going to have my upper plenum filled up to here or here. Either way, I've still got liquid above the core.

MEMBER REMPE: Okay, thank you.

MR. KAIZER: The core radial mesh sensitivity which was I think what we've already talked about and that is conservative because their treatment of CCFL, they did a core axial mesh sensitivity analysis and extended decay heat.

Axial power shape, the break size sensitivities we already mentioned and break orientation.

And, I think the most important one for us was the open barrel-baffle region. I don't know if you guys have ever seen it, Westinghouse has a video of the holes in the barrel-baffle region and they inject fiber and they just B you sit there and watch these holes not clog.

And, I mean, the water just not only streams up, but around the hole because of the flow acceleration, there's this thin area because the rest of the plate collects with fiber, but there's this thin area where it's seamless because the flow acceleration.

So, I believe that there is a large amount of evidence that says you are not going to block the open barrel-baffle region.

And so, then, we asked them, okay, the most likely simulation, what's the one that's the most realistic would have been their sensitivity for open barrel-baffle. And, even in that case, they didn't credit any of the horizontal flow channels to the core.

So, the water had to flow in the barrel-baffle up and then kind of spill over. And, in that case, nothing happens as you would expect. The water flows into the core, dumps and goes up.

MEMBER KIRCHNER: Joshua, on the CCFL, does the debris accumulate on the top of the core or the upper grid spacers?

MR. KAIZER: So, I talk B in the SE I talk about the debris accumulating in the grid spacers itself.

I wasn't sure, and I B South Texas said they apply the CCLF model because you can only really apply it in one location when you're doing this analysis.

They say they apply it at the top of the grid spacers, so the very top of the core.

I talked with Steve Bajorek and he said, well, sometimes you would apply it at the upper B at the B

MEMBER KIRCHNER: Upper core plate?

MR. KAIZER: Upper core plate, sometimes you apply it there.

There is no B there was no analysis of debris internal to the core. And, we try B I mean we address that in the safety evaluation.

And, it was one of those arguments where it can make things better, it can make things worse and I think the ultimate conclusion is, if you do get debris there, you are crediting the fact that it is an open lattice core and you're saying that if I have debris pile up here, I'm still going to be able to get flow from other areas.

So, for B

MEMBER KIRCHNER: Okay.

MR. KAIZER: -- PWRs, that's what we were thinking.

All right, next slide, please?

Uncertainty analysis, we believe they did capture the importance sources of uncertainty. ECCS flow rate is an interesting one. I think Steve alluded to this earlier.

You don't B normally, you use N minus 1 trains. Here, you don't want to because the more trains you use, the faster B the more debris you get in and the faster you'll actually build up debris.

MEMBER KIRCHNER: But you already assume the core is block so B

MR. KAIZER: Yes.

MEMBER KIRCHNER: -- it doesn't matter?

MR. KAIZER: Yes, for that analysis, yes.

Okay, and then, the quality assurance program, this was the first RAI I think we asked this right away because when you're dealing with a contractor who B I mean, Texas A&M are very smart, but they haven't performed this type of analysis before. So, that was a major B very large focus for us.

And, the first RAI we asked was, hey, this is 10 CFR 50.46 analysis. Is this done under a quality assurance program. And so, South Texas did everything they needed to do to make sure that this was done under their quality assurance program.

Moreover, we were able to review the simulations, ask questions when we needed to. So, we felt we had a high degree of confidence for the quality assurance program.

CO-CHAIR CORRADINI: So, because I think I know what you mean there, what you're really meaning is is that you had a check and a double check in terms of the models and there was a data book that you could look at and verify and audit B

MR. KAIZER: Yes.

CO-CHAIR CORRADINI: -- in terms of B okay.

MR. KAIZER: And, there were B I mean, there was B one of the main things I think that's in the Appendix B is, you have the independent peer review.

CO-CHAIR CORRADINI: Yes.

MR. KAIZER: So, the person that was doing the analysis would be one and then the reviewer would be a different signer and all that stuff.

MEMBER REMPE: So, were they students? And so, you had a student generate the model and then another student check the model?

MR. KAIZER: Not the B

MEMBER REMPE: Or how did B

MR. KAIZER: They had smart people like students, yes.

MEMBER REMPE: I know, but that B is that what you B

MR. KAIZER: I don’t B

MEMBER REMPE: -- I mean, just different people at Texas A&M?

MR. KAIZER: I don’t remember who was the actual generator. I know, I believe Rodolfo signed off on some things and I think Ernie Kee did as well with B

MEMBER REMPE: Oh, so it was actually South Texas --

MR. KAIZER: Yes.

MEMBER REMPE: -- versus folks at Texas A&M?

MR. KAIZER: Yes, because it would B it was very important to us that it was B this was done under the South Texas Appendix B QA program.

MEMBER REMPE: Okay.

MR. KAIZER: So, that was B

MEMBER REMPE: That helps. I didn’t quite get that from your Appendix, thank you.

MR. KAIZER: Yes.

All right, so, this is the summary. These are the conservatisms, simplifications we believe they used. Full core blockage as quick as they did, ignoring flow through the barrel-baffle region was, we believed, a very large conservatism.

Ignoring flow through the B those are the horizontal flow holes.

MR. KAIZER: There's the horizontal flow hose, the biased input parameters and the way their treatment of CCFL would have made it worse, i.e., you saw the effects of CCFL and you saw the effects of flooding more than you would in reality, that's what we believe.

MR. ANZALONE: And I think, just to highlight that, Dr. Corradini, I think that answers your question from earlier about what was it that allowed us to buy off on this. We felt comfortable with the way they had modeled the core as a single radial node, with CCFL up at the top, that that would inhibit as much flow as possible going down into it.

MR. KAIZER: And it was for these reasons that we said okay, we believe this builds an adequate safety case.

So that is the end of my presentation. If there are more questions --

CO-CHAIR CORRADINI: Bill, do you have questions? Take yourself off mute.

Okay, I guess he does not.

MEMBER MARCH-LEUBA: I don't hear the crackling.

CO-CHAIR CORRADINI: Crackling? Can we get a crackle? Crackle check, please.

MR. FONG: Before we get started, Mr. Chairman, I was wondering if you could help me understand. Do we have a hard stop at 11:50?

CO-CHAIR CORRADINI: We do not.

MR. FONG: Okay, we'll move things along.

CO-CHAIR CORRADINI: We can -- I'm hoping to -- the answer to your question is we do not. Some of us have to leave for a noon meeting but we will -- some of us will soldier on past noon, if necessary.

I think South Texas has some questions that we have left them to answer. If they can't, we'll come back to how we'll deal with that potentially at a later date but you go ahead.

MR. FONG: All right, thank you.

One thing I would like to also do real quick is to acknowledge Steve Lauer, I think you guys remember Steve but he retired last December. So, he's on a boat fishing in Florida somewhere, but he put in a lot of work over the last four years and really contributed a lot in the PRA portion of this review. So I wanted to thank him on the record here.

And as was said earlier, we also relied on Southwest Research and Dr. Pensado and his team did a lot of great work for us. So I wanted to give them some credit as well.

With that, I will introduce, to my left here, I have Dr. Candace de Messieres, and she will kick things off for us.

MS. DE MESSIERES: All right, thanks, C.J.

You have seen these slides before. We're going to be focusing in on elements four and five, the risk portion of the presentation. And here, again, we will just be focusing on those scenarios, cases which we not screened deterministically. So we're going to describe those cases using the risk-informed analyses.

In our safety presentation, our safety evaluation, we organized it in a way such that we reviewed the base PRA model. First, this includes the scope level of detail and PRA technical adequacy, the consistency with the ASME PRA standard, as endorsed by Reg Guide 1.200.

The next portion of the safety evaluation, we looked at the risk analysis approach, the scope of the systematic risk assessment, the initiative event frequencies, failure mode identification, scenario development, systematic risk assessment and sensitivity and uncertainty analyses.

I have highlighted here the initiating event frequencies section, as well as the systematic risk assessment section, in response to previous ACRS inquiries regarding the use of non-consensus models and assumptions. I'm going to briefly touch on those in the next slide.

The licensee considered both geometric and arithmetic mean aggregation schemes. And just for the benefit of those who are newer to this project, this is with regard to how LOCA frequency is aggregated, the results from NUREG-1829 estimating LOCA frequencies through the elicitation process.

The next key assumption is the LOCA frequency allocation to various break locations according only to break size. This is hereafter referred to as the top down approach.

And then the third key assumption that we are going to be discussing is the complete versus partial breaks. That is, the continuum break assumption in that a complete break of a given size in one pipe is equally as likely as a partial break of the same size in a larger pipe.

The other method here is the double-ended guillotine break only assumption and that only complete double-ended guillotine breaks were evaluated. And I think we had some questions about that earlier, that C.J. will be addressing in more detail.

MR. FONG: Thanks, Candace. I think what I would like to do here is go back one slide, Lisa.

I would like to first say that these are three complex topics and can get into all three of them. I would like to acknowledge the licensee in this case because I felt like they made a good-faith effort to provide a variety of different results under various assumptions. So you will see, for example, in their LAR they presented results with both the geometric and arithmetic scheme. They looked at the so-called continuum break assumption and the double-ended guillotine break only assumption. They also provided mean results but other percentiles as well.

So we felt like consistent with ACRS guidance we've received in the past, if there's uncertainty, not just looking at one model but trying to understand the effect of those key assumptions on those final results is key.

And so for issues 1 and 3, or key assumptions 1 and 3 you see here, we felt the licensee did provide a reasonable set of results. And although there is not a consensus approach out there, we felt the sum of the results was enough to give us some confidence that the risk was calculated accurately.

However, for number 2, as you guys know, that is a tricky issue. We ran into that a little bit with Reg Guide 1.229 and we still don't have a kind of universal approach for how to handle that.

So what we did was -- if you have the next slide, Lisa, we performed this bounding calc as you see here. And I will point out that this has been presented to the ACRS a few times in the past, most recently in April of last year and you see the ADAMS number there. But essentially what we did was we assumed that any break larger than what we're calling the critical break size, the smallest critical break size, which as we said earlier is 12.8 inches, anything larger than that we assume goes to core damage, regardless of its location, regardless of its proximity to problematic debris. And we used the arithmetic mean aggregation numbers from NUREG-1829 in this calculation.

And if you go to the next slide, you will see here how that is represented graphically and compared to the risk acceptance guidelines in Reg Guide 1.174.

So, as I said before, the licensee presented a range of values. You see those on the bottom there. We feel like that's important to understand the sensitivity.

We performed a bounding calc to sort of envelope all those and address really all three key sources of uncertainty. And you see here there is still significant margin to the Reg Guide 1.174 acceptance guideline.

I'll point out that what you're looking at here is core damage frequency or CDF. We also did this for LERF and found it to be acceptable as well. Next slide, please.

So in summary, we felt that the licensee either used consensus methods, explored a range of reasonable alternatives, or their numbers fell within the staff's bounding calculation. So we felt -- again, we didn't make any final conclusions but it appears, based on this, that the increase in risk is consistent with the risk acceptance guidelines 1.174.

CO-CHAIR CORRADINI: So I'm going to ask, Dr. Shack, did you have a question at this point, before they move on?

MR. SHACK: No, just a comment. I think there is -- you just don't have a consensus way to do this. So it seems to me that the bounding calculation is important to provide confidence but it does.

CO-CHAIR CORRADINI: So I have a question, which will spur Mr. Stetkar to come after me, I hope.

So the bounding calculation, does it have the same -- I don't remember actually because I can't find it on my computer as fast as John can, does the bounding calculation also show the same sort of lower valuing of the continuum when you do the bounding or does it increase? We looked at, essentially, one train versus two trains and operation. You know what I'm asking?

MR. FONG: Yes, so that's factored in. So the bounding calculation looks at both the one train and two train cases and weights them according to their conditional probability.

CO-CHAIR CORRADINI: Which is like 99.6 versus -- or 99.96 and 0.04 and whatever.

MR. FONG: Yes.

CO-CHAIR STETKAR: In the SER, I'm looking at it right here, you actually did both geometric and arithmetic averaging. I mean you reproduced the case 1 and case 2, which is two or more trains, only one train for both geometric and arithmetic averaging but just with the assumption that all of the breaks had the frequency of the smallest break for each of those case 1 and case 2. Is that --

MR. FONG: That's it.

CO-CHAIR STETKAR: That's what I understand.

MR. FONG: Yes.

CO-CHAIR STETKAR: So you used a 12.8 and a 9.3 or whatever the heck it was for the two break sizes. And you weighted them by the fractions that the --

MR. FONG: Correct.

CO-CHAIR STETKAR: -- licensee has.

MR. FONG: Okay, thanks. Next slide.

MS. DE MESSIERES: Okay, I'm going to discuss a little bit about Principle 5 performance monitoring. Before I go into the specific bullet points here, I'd like to mention that whenever possible, the staff did make an effort to create a structure that leveraged existing infrastructure already in place. So the idea was not to create new burdensome reporting requirements but to rather use those existing processes to further enhance the security with regard to performance monitoring.

So in terms of the specifics, we have a risk analysis reviewed and updated every 48 months. Procedural controls have been developed to prevent and mitigate debris in containment. For example, tech spec surveillance requirements requiring visual inspection and design change control for ensuring new debris sources are properly addressed.

The NRC is notified if acceptance guidelines are exceeded. For example, 50.73 report if the substrainer is inoperable longer than its completion time per its standard tech spec requirements. Another example of that would be 50.742 or 50.73 if the Reg Guide 1174 delta CDF or delta LERF criteria are exceeded., again going back to the slide before, where you saw that great margin. So it's not every tiny small change. It's if our acceptance criteria is exceeded.

We already heard a discussion earlier about the specific methods and assumptions that are now actually going to be included in an appendix, as part of the FSAR. And in these cases, that will, as specified as a licensing-basis document, that will trip the 50.59 criteria for change processes. And so those are kind of the key features of the performance monitoring program that offer the staff assurance that the analyses that we're presented with today will continue to assure safety going into the future.

CO-CHAIR STETKAR: Just an editorial comment in your SER. I had a question earlier about cold shutdown versus hot shutdown. In the SER for the ECCS you quote the cold shutdown criterion. So you may want to clean that. It's Section 5.3 of your SER, where you talk about the tech spec changes. That's just editorial but it's important because it is -- you're quoting the tech specs.

MS. REGNER: Yes, thank you.

MR. FONG: So to summarize, kind of in plain English, we looked at the risk calculation the licensee performed as kind of a snapshot. So if you read Reg Guide 1.174, it talks about not just the risk being acceptable today, but other controls are in place to ensure that the safety is not eroded long-term and there aren't a series of smaller changes that increase the risk to an unacceptable level in the future. And that's principle 5. And so we looked at both of those and came away with some assurance that the risk is acceptable now and there are controls in place to ensure that it remains that way.

That's it.

MS. REGNER: So just in summary -- actually --

CO-CHAIR STETKAR: Corradini yells at me if I scream at you.

MS. REGNER: I just didn't quite want to leave risk yet, if there were more questions.

CO-CHAIR CORRADINI: Well, I'm sure we're going to go back.

MS. REGNER: Okay. Well, this is just an overall summary, a very big picture. The staff does believe STP acceptably evaluated the impact of debris by considering both risk and deterministic aspects.

The break scenarios are addressed using conservative deterministic -- most break scenarios do fall under the traditional deterministic methods. They're long-term core cooling evaluation method and simulations are conservative meet acceptance criteria. And their debris analysis meets the key principles of risk-informed regulation, including the PRA results showing that the change in risk is very small and meets the Commission's risk policy -- safety policy.

MR. FONG: Consistent with the Commission's Safety Policy Statement.

MS. REGNER: You've said that before.

MR. FONG: Once or twice, yes.

MS. REGNER: Thank you, C.J.

MR. FONG: Thank you, Lisa.

CO-CHAIR CORRADINI: So here's I'd like to proceed. We have to go to public comments but before I do, I'm going to turn to South Texas and we left them with three items. Do they want to address them or do they need to go and do more homework?

Go to a microphone. Identify yourself with sufficient clarity and volume.

MR. MURRAY: This is Mike Murray. We'd like to do homework and make sure we have a precise answer.

CO-CHAIR CORRADINI: Okay, fine. Okay. So, do we have any other questions from the members? Bill, as our consultant out in the beautiful northern Midwest, do you have any questions?

MR. SHACK: No, no further questions.

CO-CHAIR CORRADINI: Okay, so we don't go to public comments? Are there anybody in the room that wants to make a comment, please step to the mike and can you get the public line open or is Bill on the public line?

So is anybody on the public line that wants to make a comment, please at least make a noise that we know you're out there.

MR. LEWIS: Marvin Lewis, member of the public.

CO-CHAIR CORRADINI: Okay, could you please state your name and give us your comments, sir?

MR. LEWIS: Marvin Lewis, member of the public.

I have really enjoyed this meeting about GS-191 which we have been on for a heck of a long time and I haven't answered all the questions.

And my problem is, and I hope I'm wrong, as much time and effort as has been put into all the possible debris blockages and whatever, that it is still hard for me to believe that we will know every -- and we'll know it. Thank you.

CO-CHAIR CORRADINI: All right. Thank you. Thank you, Mr. Lewis.

Is there anybody else on the public line that wants to make a comment?

Okay, hearing none, why don't we close the public line, please.

So let me go around the table with the members. Are there any comments by the members in closing?

I will, before I get there, we are

scheduled to write a letter report on this in May. If we need to get back together, there is potentially an opening two weeks from yesterday for a subcommittee meeting so that we can clearly answer questions from STP or the staff. I've been told by our ACRS staff that there is an opening that was a meeting but now is open. So if we need to have us get back together, which I think we will, that will probably be two weeks from yesterday.

So a letter is still planned for May.

Comments by the members? Ron?

MEMBER BALLINGER: No, no comment.

CO-CHAIR CORRADINI: Matt?

MEMBER SUNSERI: No, comments, thanks.

CO-CHAIR CORRADINI: Dana?

MEMBER POWERS: Well, I don't have comments on the particular issue before us.

I do look at this possibly created to examine the sump blockage issue and I see we've got a fairly rigid catechism that we followed. We are asking things to go for a very long time and I start thinking about gee, what kinds of things occur in the very long-term we may not have recognized.

And I said I my note to you, we're not

thinking about how this debris evolves on the sump and how it can affect subsequently the cooling of the core. The thing that comes to my immediate attention is we have a solution flowing through a bunch of solids that have not previously been incorporated with the liquid so they are going to go try to incorporate in the long-term and one of the ways of doing that is to dissolve and reprecipitate.

But the solution we have is one of a fairly concentrated boric acid and it will also be contaminated with carbonates and possibly in some plants with phosphates. And those are ions which are famous for having measurably slow precipitation kinetics. And I'm thinking that maybe in our longer term we ought to think about the potential of having dissolution re-precipitation where the re-precipitation is occurring where the kinetics get fast, that is where the temperature gets hot and that is in the core region.

I don't know that we have an issue here but it's an area that I think I would like to give some more thought. It's not pertinent to the particular question we are dealing with here but it is more of a long-term issue.

CO-CHAIR CORRADINI: Okay, thank you, Dana. And I've got your note that explains the chemistry, as far as I can understand it.

Dennis?

MEMBER BLEY: Nothing additional, except about another meeting. I think before we finish today, it would be good to talk that through.

The questions that are sitting out seem to me might be amenable just to covering them in the full committee meeting, rather than a separate subcommittee but I'm not sure of that.

CO-CHAIR CORRADINI: I don't know what our schedule is but I wanted to leave the possibility of having something in-between so we don't get caught with not enough time in the full committee and still open items that would get everybody a bit --

MEMBER BLEY: Well, then we should probably put it on the agenda today.

CO-CHAIR CORRADINI: Member Stetkar.

CO-CHAIR STETKAR: I have nothing more, thank you. And again, the staff did a really good job. Thank you.

MEMBER MARCH-LEUBA: I haven't been here long enough to be following GSI-191, we know it has obviously, but from what I read and what I hear, I think STP and the staff has done a very good job of trying to bound the problem and find a solution for it, which I think is fairly reasonable.

One thing I really like to hear was a comment from the staff about how to approach problems of validation of COLs. And typically the solution there is always making more complex. And I loved the comment of simplify the COL, simplify the approach and you can validate it. So I really want to second that one.

CO-CHAIR CORRADINI: Walt.

MEMBER KIRCHNER: Thank you to the staff and STP. I would just observe that this I will call it, quote, unquote, an evaluation model approach to the problem I think is acceptable and bounds the phenomena.

I think I would observe that it would be very difficult to do what I will call a dynamic calculation of the core blockage as it accumulates and whether the 15 grams per fuel assembly is a threshold or not. I would find that hard to validate, based on real prototypical testing.

So I felt that what we heard, as you said, a nice way to address a very complicated problem and adequate deterministic manner for that set of the problems.

Thank you.

MEMBER REMPE: No additional comments. Thanks for your presentation.

CO-CHAIR CORRADINI: Okay, so I want to thank the staff and the applicant.

I do think I won't use this as a model but I will say that SE and how it was put together, if this is how you explain risk-informed approaches, I would say this is a good model to go for the future. I think it was very helpful to me, since I have a hard time with this, even though I have been around the two people to my right way too long.

Now, let's get to some particulars. We a full committee session planned in May about this. I would like to plan for a meeting two weeks from yesterday in the morning as a subcommittee meeting just in case, so we get very clear any sort of explanations that clarify the answers for some of the members, which you have. I have three and now I've lost them.

I have three that I have that are kind of sitting out there. Single train full flow -- what is the NPSH margin and what was done, if something was done? Secondly, differences in the risk results versus two to three trains versus single train values; continuum models, why are they lower? What the trend seems to be in the oppositive qualitative direction than expected and the tech specs? What is mode 4 in terms of starting pressure and number of trains that needs to be in operation? And I think I've got them approximately right.

John?

CO-CHAIR STETKAR: Approximately.

CO-CHAIR CORRADINI: Approximately. Okay, I don't shoot for anything more than approximate.

So is the staff able to support a subcommittee meeting weeks from yesterday?

MS. REGNER: Of course, the staff will support.

CO-CHAIR CORRADINI: Bless your heart.

MS. REGNER: It sounds like how much staff involvement will you --

CO-CHAIR CORRADINI: You need to be green.

MS. REGNER: Sorry, yes. The answer is yes.

CO-CHAIR CORRADINI: Okay and I don't know how much involvement but I think we need the appropriate people on staff here so that, as I understood it, I am personally comfortable with the bounding calculation for the staff but what Member Stetkar is asking is how can he ascribe credence to the calculations of STP if they seem to go qualitatively in a surprising direction, even though you have bounded it.

So I still think we need staff around to be part of the conversation.

MS. REGNER: Oh, the staff will definitely be around.

CO-CHAIR STETKAR: Dr. Corradini, sir, looking at my current understanding of what happens the first week in May --

CO-CHAIR CORRADINI: No, I'm talking about two weeks from yesterday is April the 18th.

CO-CHAIR STETKAR: Well two weeks from yesterday would have been May 4th.

CO-CHAIR CORRADINI: No.

MEMBER REMPE: April 18th the MELCOR.

CO-CHAIR STETKAR: Oh, two weeks. Okay, sorry. NuScale. Sorry. By the way, Mike, I have to say this. This is characterized as a risk-informed approach. It is about the minimalist risk-informed as you can get something.

CO-CHAIR CORRADINI: That's why I like it.

CO-CHAIR STETKAR: They have quantified frequencies of pipe break LOCAs and they have used the risk model to calculate two numbers. One number is the conditional probability that you have one and only one train of equipment operating versus two or more and the other one is the conditional large early release frequency, given no flow from the sump. That is about as minimal as you can get.

A lot of my questions are trying to probe have they thought broader in the scope of risk to look at mode 4 conditions, to look at the seismic stuff, to understand this one train versus two train versus three train type of things.

It doesn't necessarily change their approach but I'm trying to make sure that if they're trying to call this risk-informed, they have at least thought about the scope of what a real risk assessment would have addressed, which they started to do in the beginning and we all know the history of that.

CO-CHAIR CORRADINI: Okay, good. So we'll plan on something two weeks from yesterday so that we can get a full discussion of these items. We can clarify the items to make sure I have the proper words offline. Other than that, I don't have anything else, other than to thank STP and to thank the staff. I think this was, to me, very informative. It was two years so I had to do a lot of reeducation since I last thought about this. So any other comments by the members? And we're set for May for a full committee session. Okay, with that, we're adjourned.

(Whereupon, the above-entitled matter went off the record at 11:54 a.m.)

Staff Review of South Texas Project (STP) Generic Safety Issue (GSI)-191 LAR

Lisa Regner, Senior Project Manager

Office of Nuclear Reactor Regulation
Division of Operating Reactor Licensing

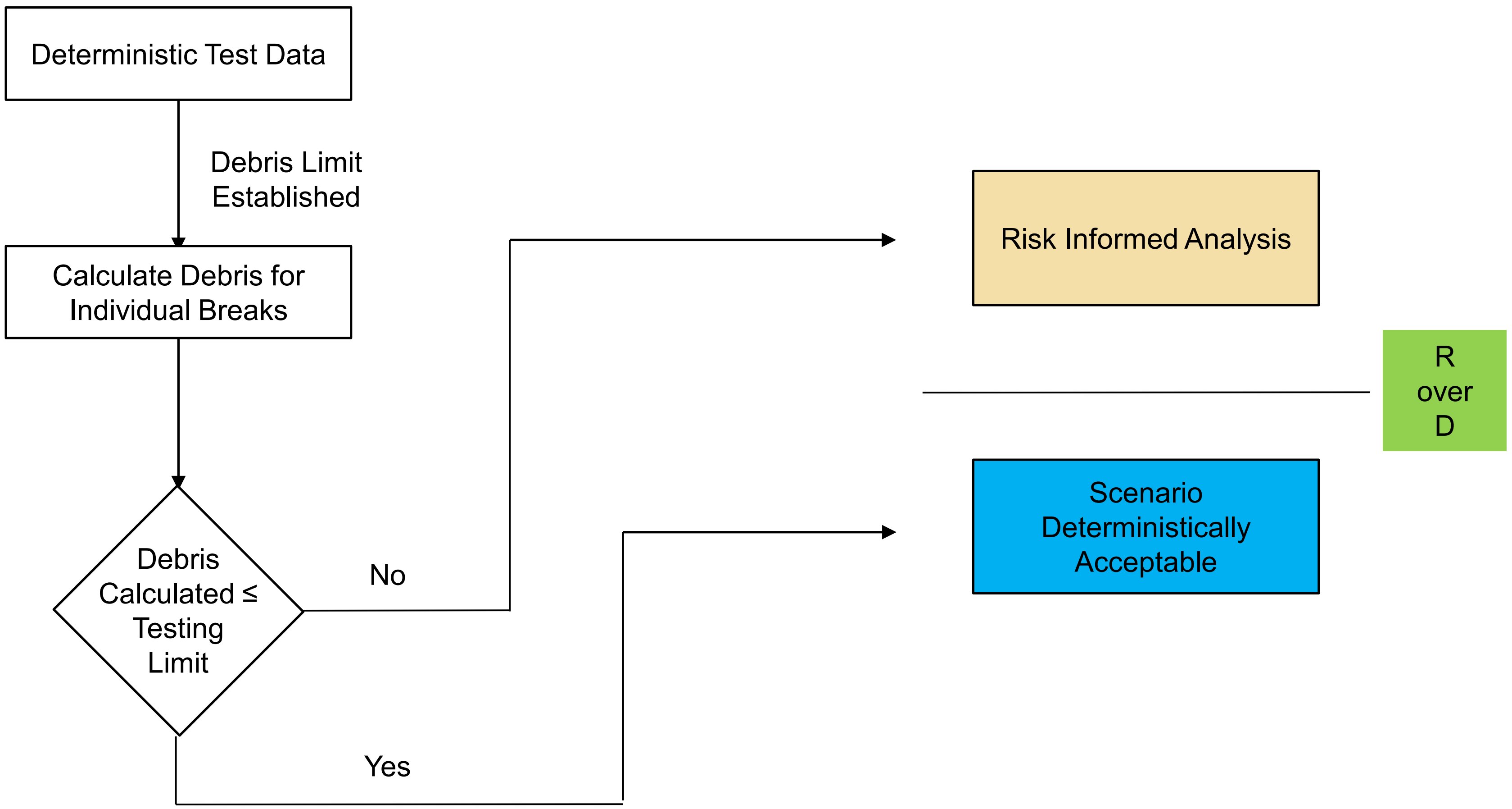
Introduction

- Background
- Overview of Licensee Methodology - RoverD
- Technical Topics
- Remaining Actions

Background

- STPNOC original request - Option 2
- Methodology adjustments and supplements
- Requests for additional information
- Public meetings
- Audits
  - Testing observations
  - Containment entry
  - Calculation and platform reviews
  - Risk analysis

Risk over Deterministic Methodology



Technical Topics

STPNOC:

- Eliminated the use of correlations for head loss and chemical effects
- Aligned with staff guidance on other aspects of the deterministic debris evaluations
- Eliminated timing aspects of the evaluation and assumed debris effects from time zero
- Resolved epoxy coating impacts
- Justified the use of RELAP5-3D for LTCC

Remaining Actions

- Complete concurrence process
- Publish final environmental assessment
- Present to full committee ACRS
- Resolve ACRS comments
- Coordinate issuance of final decision with internal and external stakeholders
- Issue final decision

STP Nuclear Operating Company Presentation

STP Risk-Informed Approach to GSI-191

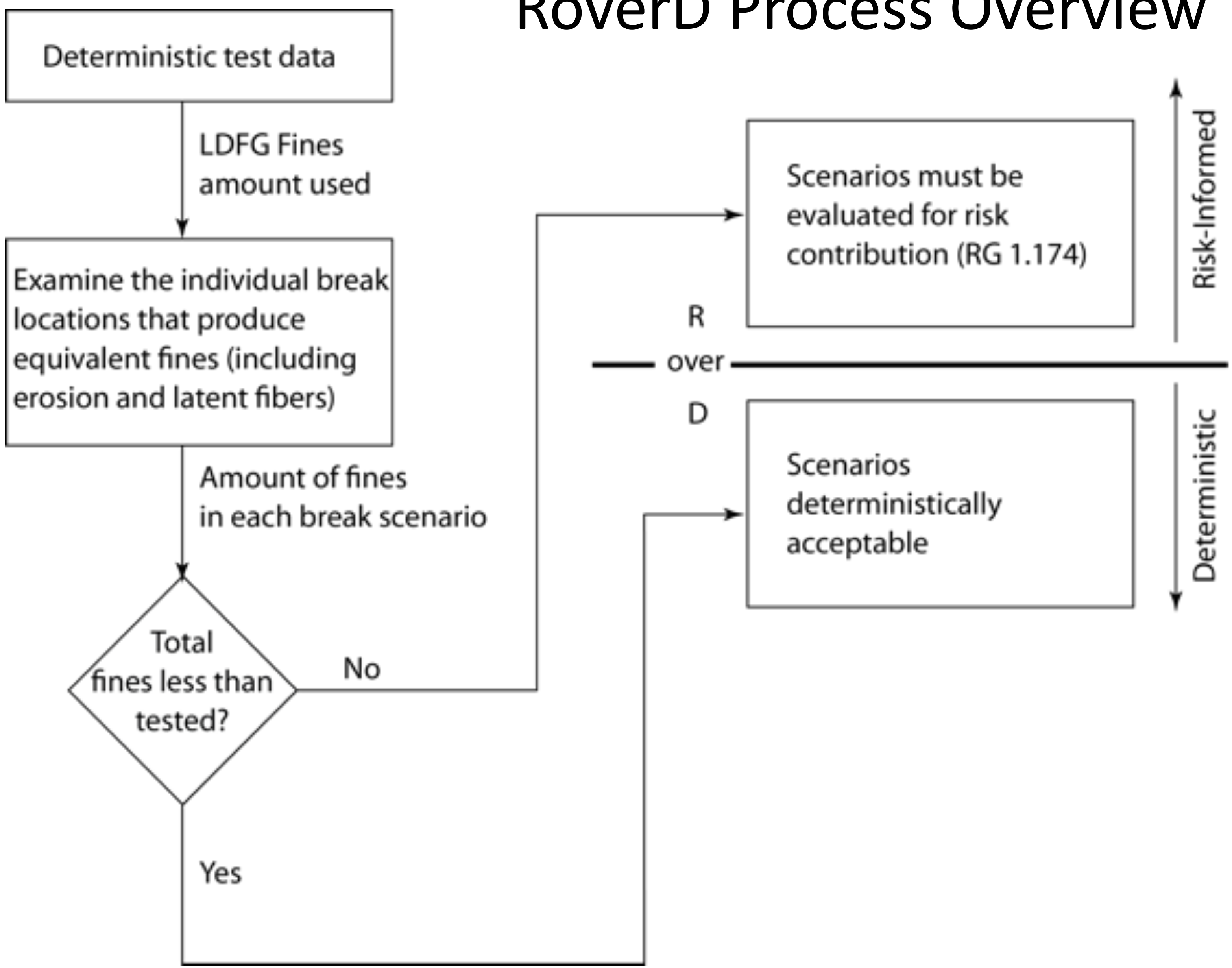
ACRS Joint Thermal Hydraulic Phenomena and Reliability and Probabilistic Risk Assessment Subcommittee Meeting

April 5, 2017

STP Agenda

- RoverD Process Overview
- Deterministic Element
- Risk Element
- Regulatory Basis
- Conclusions

RoverD Process Overview



Deterministic Element

1. STP-specific strainer performance testing addresses majority of failure concerns deterministically
2. Deterministic guidance of NEI 04-07 largely used to establish loads and performance goals
3. Flume tests designed to satisfy GL2004-02
   - Challenging fiber load on 2 trains only
   - Conservative particulate
   - 30-day WCAP chemicals (with continuous spray)
4. Used one full-scale STP strainer module at full flow
5. Flume channel designed to emulate approach velocity and turbulence
6. Debris preparation and introduction procedures acceptable
7. Large quantity of particulate in combination with chemical load caused thin-bed filtration conditions
8. Representative settling of debris allowed fine fiber to arrive at strainer
9. Successful test satisfies failure concerns up to the level of the tested debris loading
10. All performance goals set by engineering analysis were met
11. Direct comparison of break spectrum to test results eliminates need for head-loss correlation

Risk Element – Break Size and Location

- Deterministic test results show the strainers can tolerate up to at least 192 lbm of fine fiber
  - Greater amounts are assumed to cause failure
  - Detailed evaluation in accordance with NEI 04-07
- 53 break locations identified as risk-informed
  - All such breaks are large LOCAs
  - CDF determined based on the break frequency of those locations

Risk Element - Vessel/Containment

- Bounding cases showed no in-vessel failures
  - Cold leg break fiber accumulation <<15 gm/FA
  - Hot leg break cooling flow with baffle barrel and core assumed to be blocked
- Conservative RCB cases show no flashing/air entrainment through strainer
  - Assume low pressure (CHRS all support available)
  - Assume high sump temperature CHRS/RHR support unavailable (beyond design basis)
- RCB intact (pressure/temperature) with only RCFC cooling

Risk Element - ΔCDF and ΔLERF

	CDF Geometric Mean	LERF Geometric Mean
Supplement 3 (10/20/2016)		
Continuum Model	1.50E-07	3.75E-10
DEGB-only model	9.03E-08	2.26E-10
Supplement 2 (08/20/2015) - LERF methodology revised from initial version		
Continuum Model	1.23E-07	3.08E-10
DEGB-only Model	5.13E-08	1.28E-10
Initial RoverD Version (03/2015)		
Continuum Model	1.22E-07	7.67E-09
DEGB-only Model	5.32E-08	3.34E-09

Regulatory Implementation

- Debris-specific action in ECCS and CSS Technical Specifications
  – 90 day completion time for debris-only condition
- UFSAR changes
  – Ch. 3 GDC description
  – Ch. 6 Engineered Safety Features
  – Add appendix to Ch. 6 to describe debris resolution, reporting requirements and limitations on change control

- Exemptions to permit use of risk-informed approach instead of prescribed deterministic methodology
  – 10CFR50.46(a)(1) ECCS "..other properties.."
  – GDC 35 ECCS
  – GDC 38 Containment Heat Removal
  – GDC 41 Containment Cleanup
- Exemptions apply only for the effects of debris

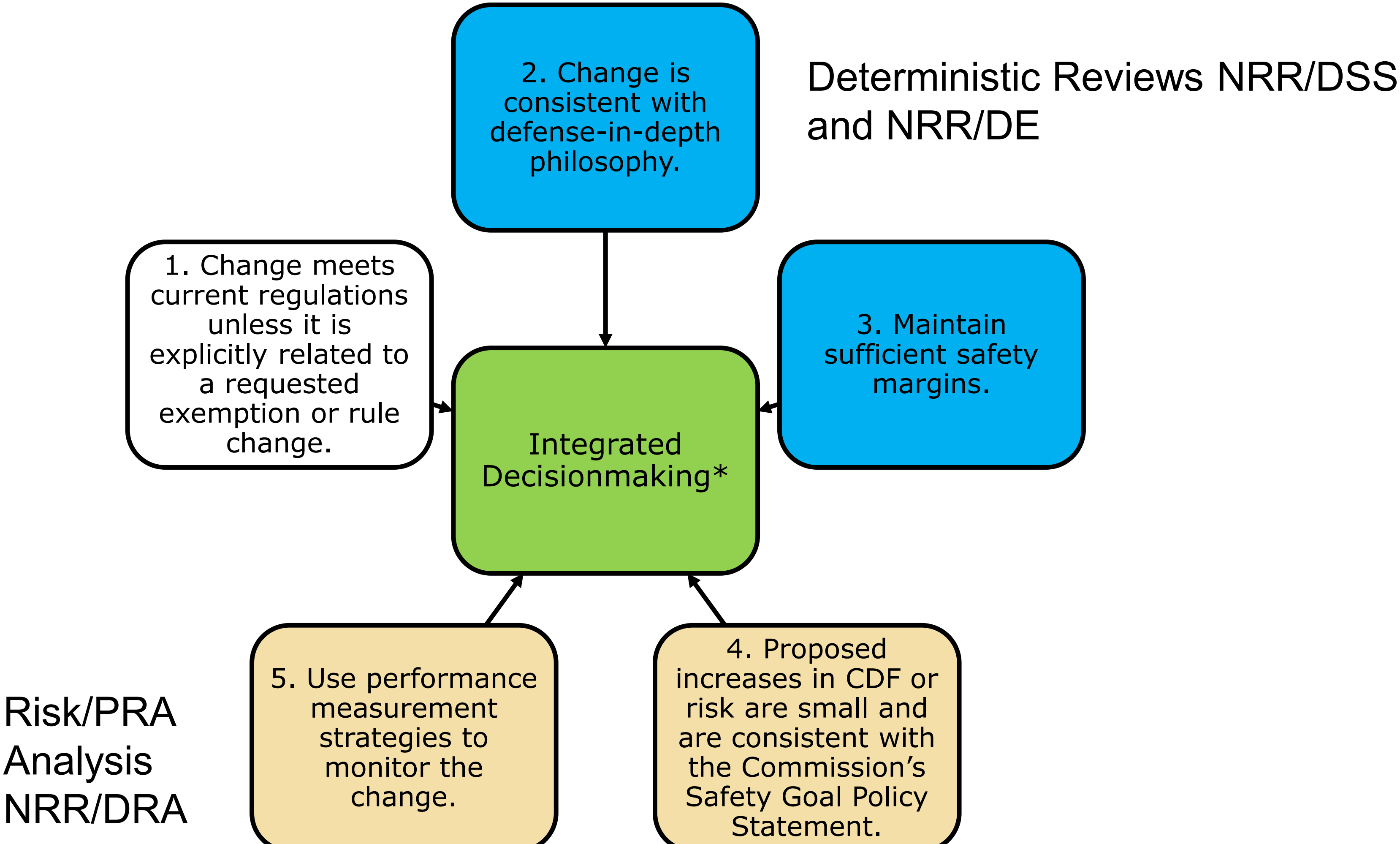
Conclusions

- The RoverD process incorporates all aspects of the debris issue
  - Debris generation and transport
  - In-core effects
  - Deterministic (testing for fiber and chemical effects)
  - Risk-informed evaluation
- RoverD demonstrates very small risk per RG 1.174

Bases of Review

- Regulatory evaluation
- Guidance
- Technical Specification change
- Structure of the NRC Staff’s safety evaluation

Staff Methodology



* Principles of Risk-informed Integrated Decisionmaking from Regulatory Guide 1.174, Rev. 2, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis" (ADAMS ML100910006).

Principle 1
Risk-Informed Regulation

"The proposed change meets current regulations unless it is explicitly related to a requested exemption..."

- 10 CFR 50.46c rulemaking status
- Exemptions requested from use of deterministic analysis method
  - Acceptance Criteria for emergency core cooling systems (ECCS)
  - General Design Criteria associated with ECCS, containment heat removal, and containment atmosphere cleanup

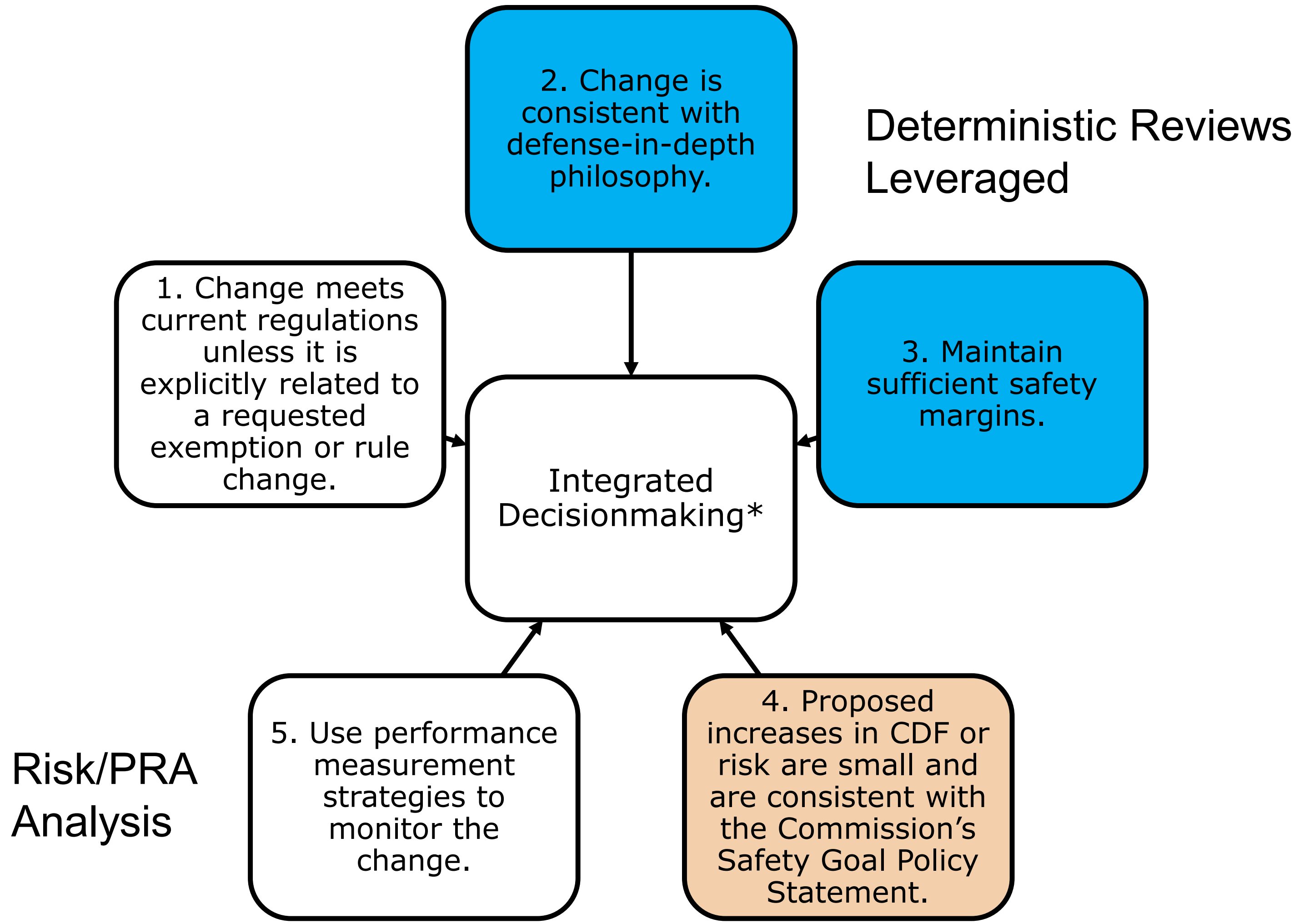
Staff Review of STP GSI-191 LAR

Principle 2: Defense-In-Depth
Principle 3: Safety Margins

Steve Smith, Senior Reactor Systems Engineer

Office of Nuclear Reactor Regulation

Integrated Decisionmaking



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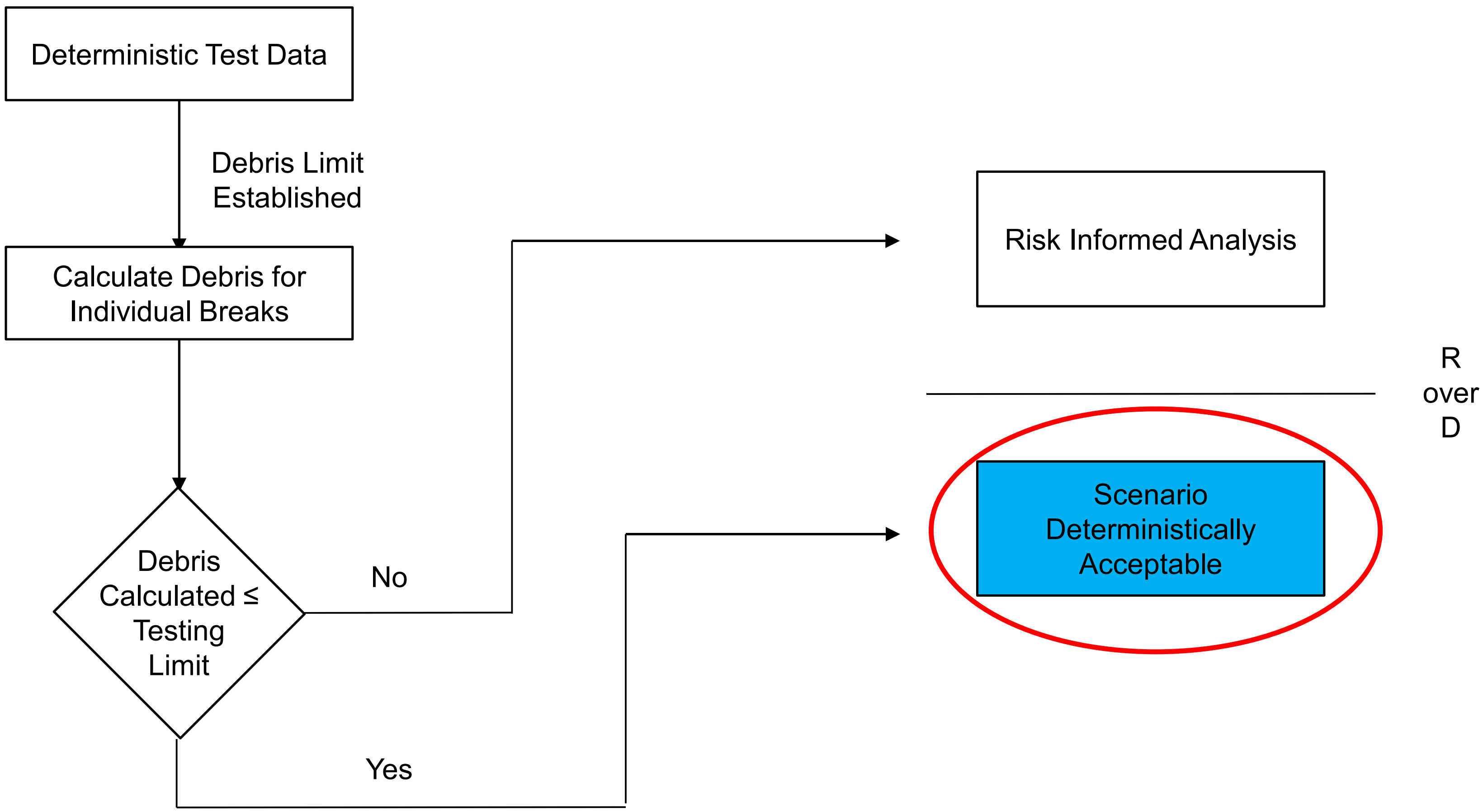
Risk over Deterministic Methodology



Principles 2 and 3
Safety Margins
Defense-In-Depth

- Licensee met guidance of RG 1.174 and listed significant Safety Margins and Defense-In-Depth
- Safety Margins include construction and inspection per industry codes and the use of licensing basis values when assigning strainer failure criteria.
- Defense-In-Depth (DiD) includes actions identified that are taken in response to the loss of the normal ECCS function. DiD also includes verification that balance is maintained among prevention and mitigation, redundancy is maintained, barrier independence is maintained, etc.

Principle 4
Deterministic Inputs to Risk Analysis

- Debris Source Term
  - Used NRC approved guidance for all areas
  - Calculations performed in CASA Grande
  - Differences from typical deterministic evaluations
    - For partial breaks, all weld locations evaluated for multiple orientations instead of focusing on the limiting location
    - DEGB source term uses the same method as typical deterministic calculations
  - Source term calculated for each break and compared against tested amount
  - The most conservative orientation was selected for partial breaks at each weld location
  - Assumptions and calculations independently verified by SwRI

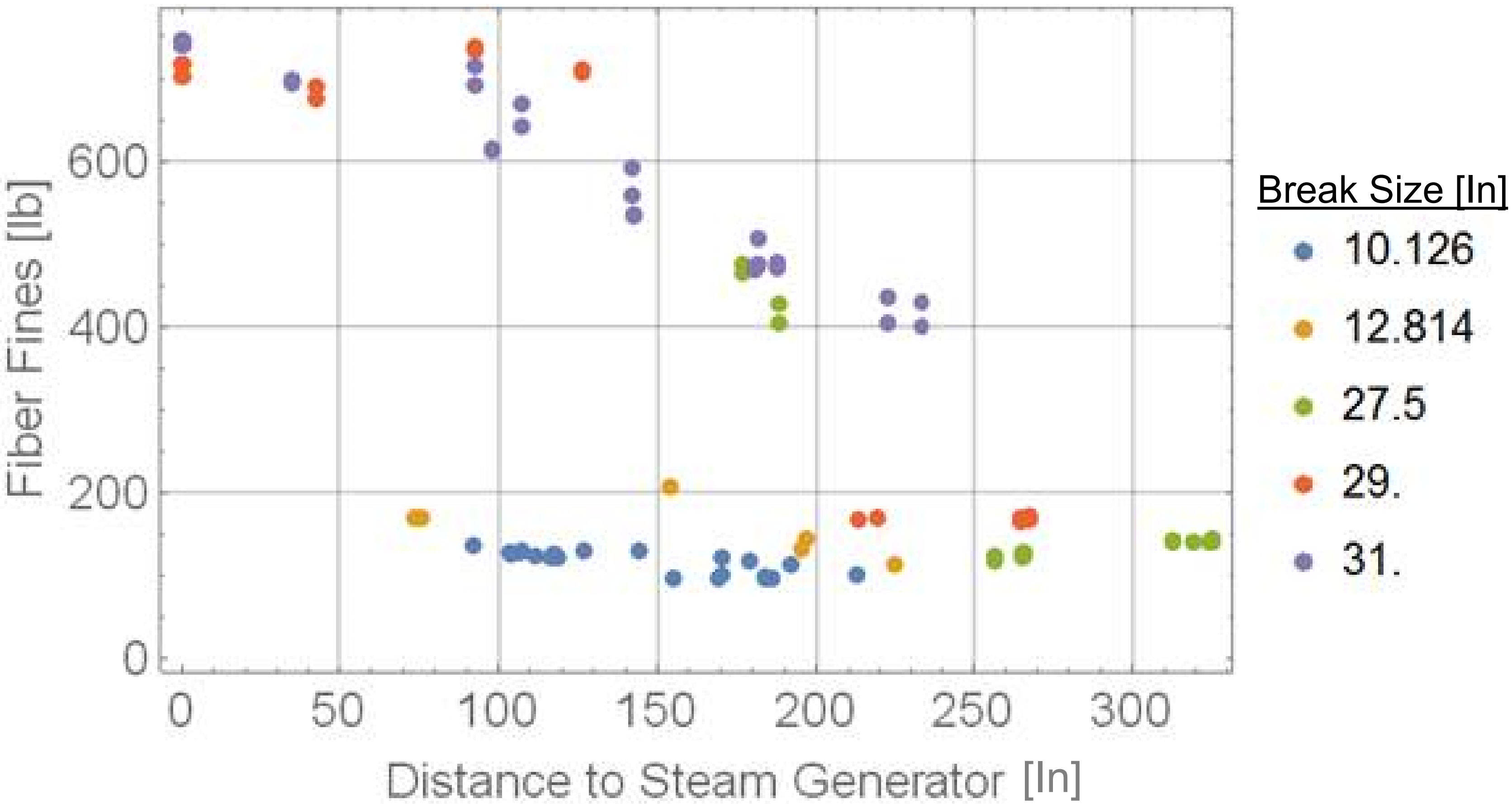
Principle 4
Deterministic Inputs to Risk Analysis

- Debris Transport – Strainer Evaluation
  - Used NRC approved guidance
- Debris Transport – In-Vessel Effects
  - Fiber penetration determined via testing
  - Test conditions varied flow rate, upstream concentration
  - Evaluated fiber amounts only for cold-leg breaks
  - Used conservative bypass values from testing
  - Calculated fiber amounts arriving at the core for cold-leg breaks considering varying plant states (pump combinations)
  - Determined fiber reaching the core in all cases is small amount (2 g/FA design basis, 4 g/FA 1 LHSI, 7 g/FA 1 HHSI)
  - Calculations independently validated by SwRI

Principle 4
Deterministic Inputs to Risk Analysis

- Impact of Debris – Strainer
  - Strainer evaluated at tested debris load/dP for NPSH, structural, deaeration, vortexing, and flashing
  - Testing shows that increasing fiber amounts results in greater head losses
    - Previous licensee test with bounding debris amounts resulted in very high head loss, even with no chemicals added
    - Subsequent tests (2008) with less debris met ECCS head loss acceptance criteria
    - Majority of breaks were bounded by 2008 test results
  - Testing was performed using staff approved guidance

Principle 4
Debris Generation Amount



Principle 4
Deterministic Inputs to Risk Analysis

- Impact of Debris – In-vessel – Cold-Leg Break
  - Debris amounts low enough to permit adequate cooling flow to the core based on WCAP-16793 findings
  - Boric Acid Precipitation not resolved by the LAR because staff has no basis to conclude that any amount of debris will not reduce mixing with the lower plenum
  - Previous staff conclusions indicate that the STP debris amounts do not result in a significant impact to BAP timing conclusions currently assumed by STP
  - Licensee to address BAP for the CL break at a later time

Staff Review of STP GSI-191 LAR

Deterministic In-vessel

Joshua Kaizer, PhD
Nuclear Performance and Code Review
Division of Safety Systems
Office of Nuclear Reactor Regulation

UNITED STATES NUCLEAR REGULATORY COMMISSION

In-Vessel Deterministic: Review Goal

Goal

- To determine if the Long Term Core Cooling (LTCC) Evaluation Model (EM) provided credible results which could be trusted for reactor safety analysis.

Challenge

- How much validation is required to justify use of the LTCC EM?
- How much validation is available to justify use of the LTCC EM?

In-Vessel Deterministic: Review Approach

Solution

- The amount of validation required is proportional to the complexity of the model… *therefore* reduce the complexity of the EM in a conservative way.

Practice

- All large breaks were treated with risk (removes the need to model complex phenomena)
- Focus only on “long term” portion of the event (removes the need to validate complex phenomena associated with blowdown, refill, reflood)

In-Vessel Deterministic: Review Scope

Break Size	Hot-Leg	Cold-Leg
Small	**LTCC EM**	RoverD
Medium (< 16”)	**LTCC EM**	RoverD
Large (>16”)	Risk Informed	RoverD

Criteria (WCAP-16793)

1. Max PCT < 800 ºF* - LTCC EM (SRP 15.0.2)
2. Debris thickness < 0.050 inches

* Preferably, not above saturation (reduces complexity).

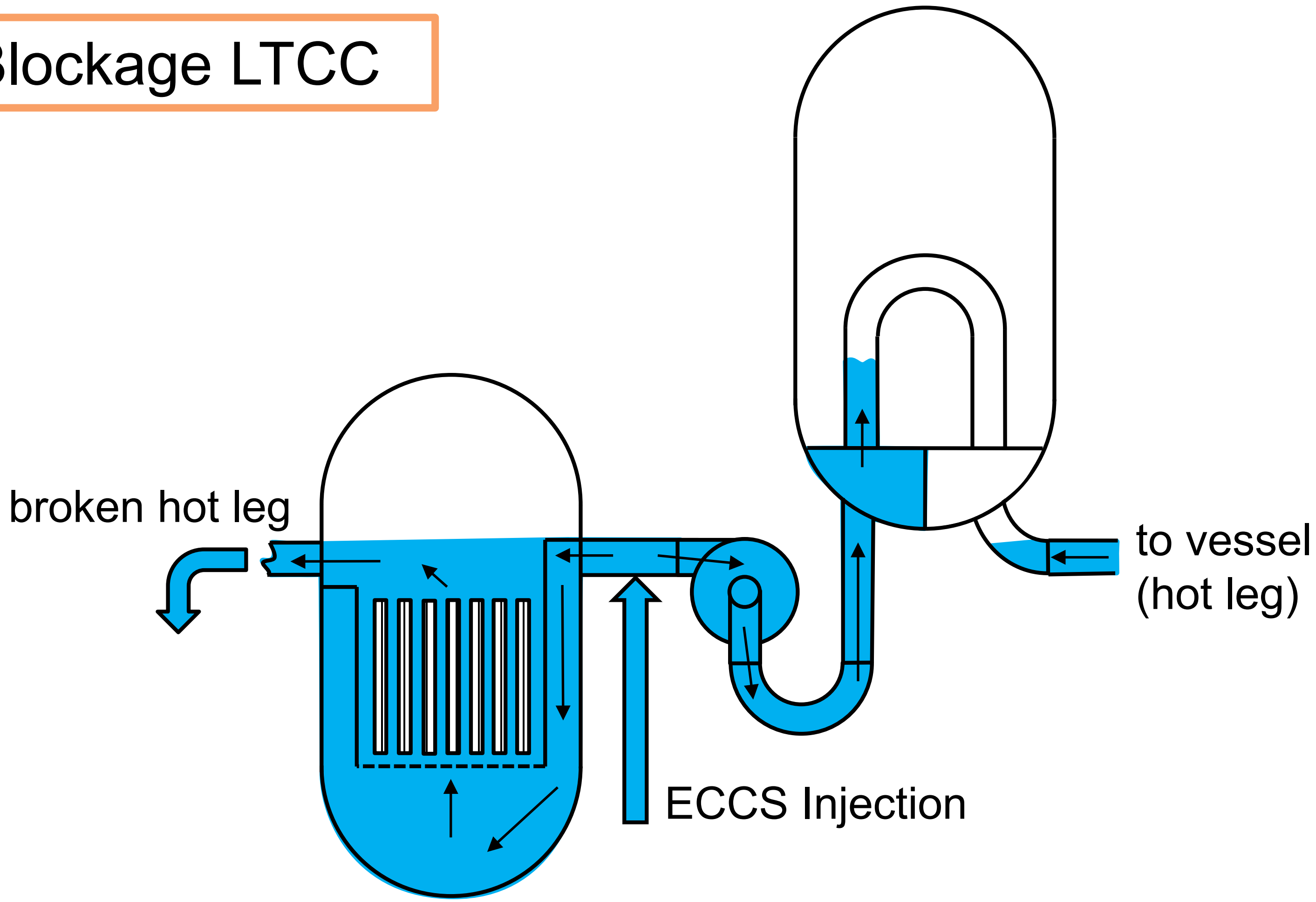
In-Vessel Deterministic: Debris Thickness

Maximum Debris Thickness

- LOCADM analysis performed assuming 91 gm/FA
- This amount was almost twice what could be reasonably expected to bypass the strainer
- Total debris thickness was under the specified limit

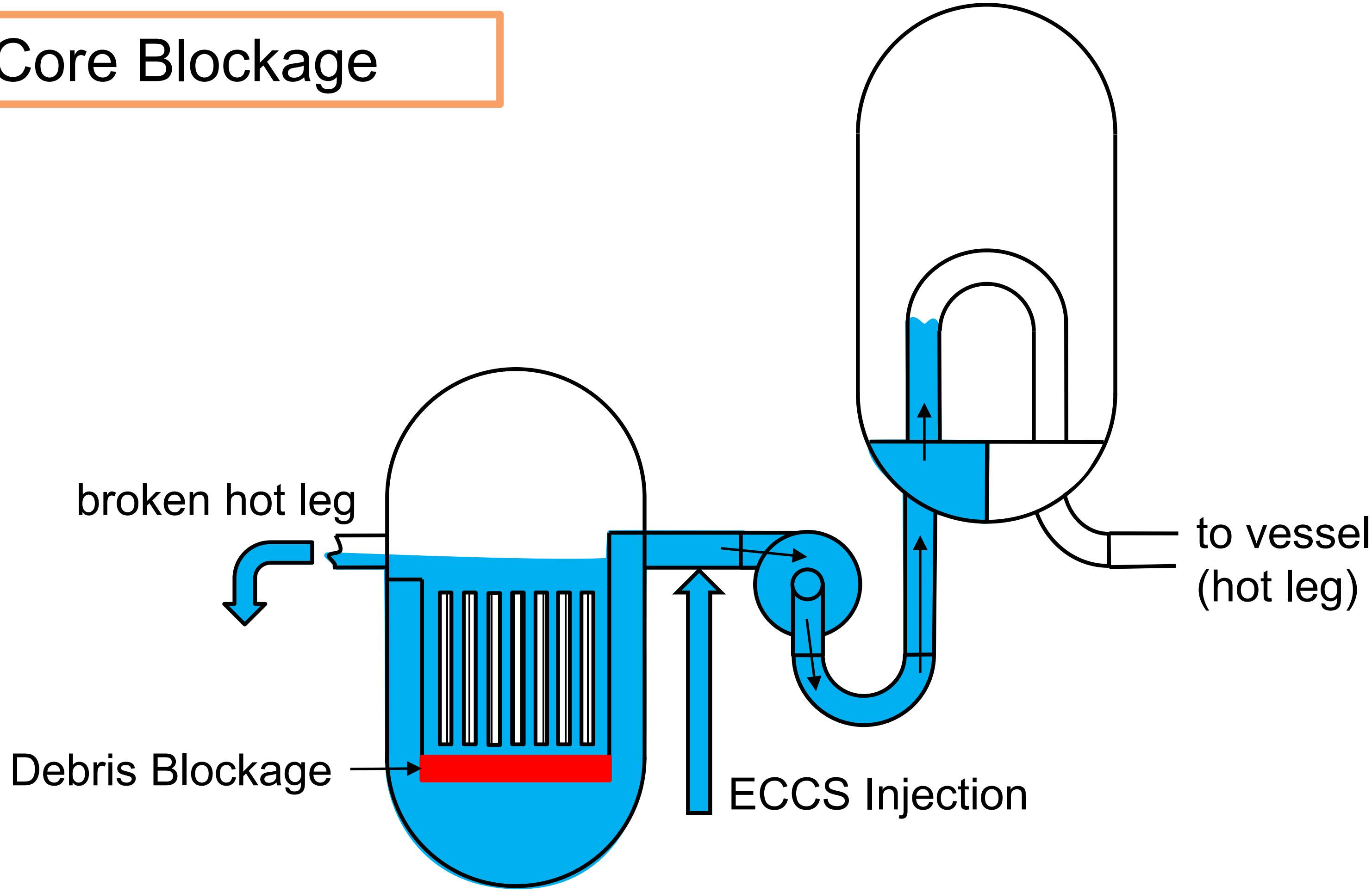
In-Vessel Deterministic: Simulation

Pre-Blockage LTCC



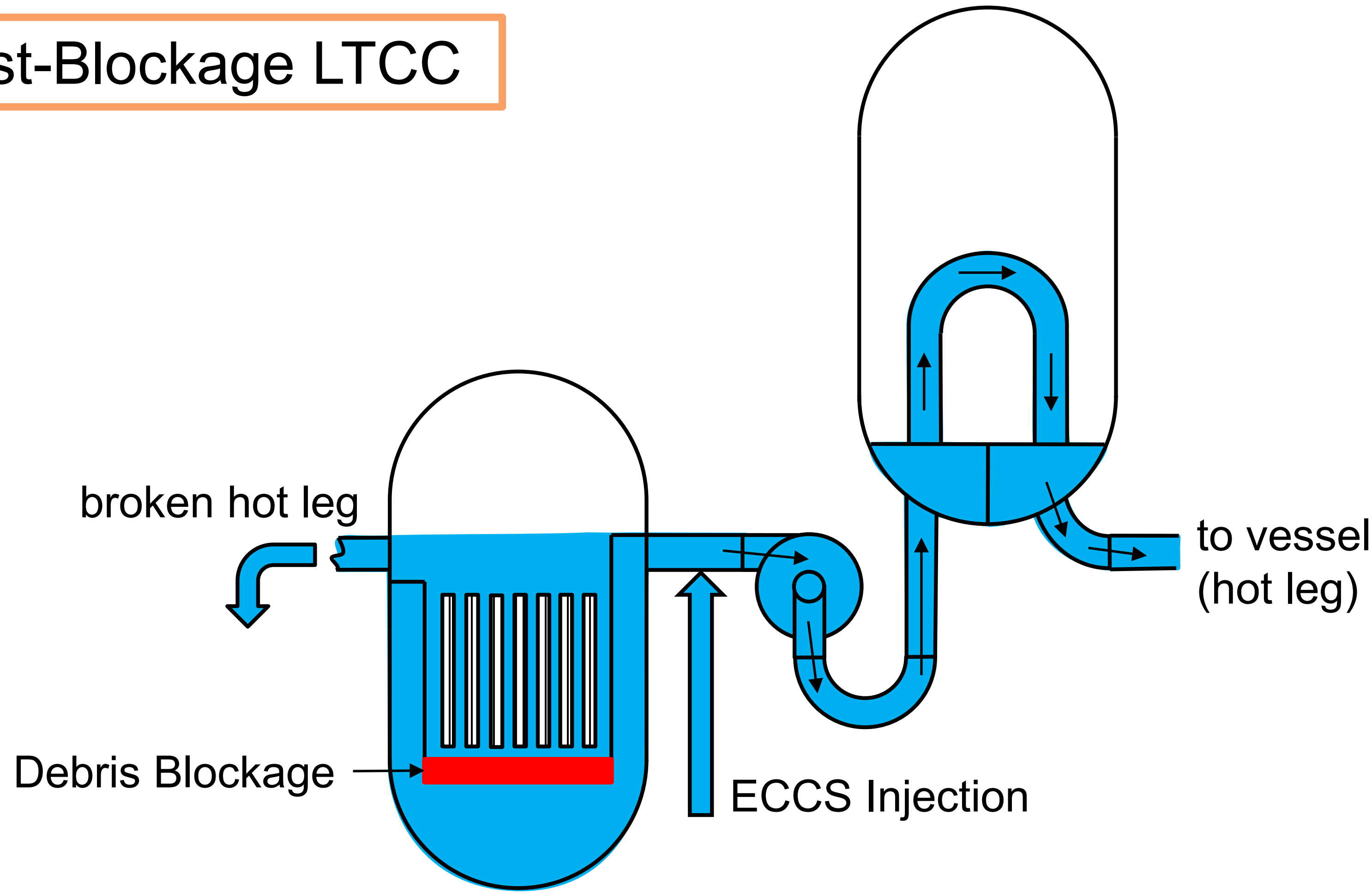
In-Vessel Deterministic: Simulation

Core Blockage



In-Vessel Deterministic: Simulation

Post-Blockage LTCC



In-Vessel Deterministic: Review of LTCC EM

Accident Scenario Identification Process

- PIRT – focusing on long term cooling phase
  - Boiling, Counter Current Flow Limitation
- Initial and Boundary Conditions
  - **Core bypass flow**, **time to full blockage**, **subcooling**, break size
  - Early blockage is conservative for two reasons

Documentation

- RELAP5-3D Manual
- Recent RAI responses

In-Vessel Deterministic: Review of LTCC EM

Evaluation Model Development

- Closure Relations
  - **CCFL Treatment**, Boiling (Chen)

Code Assessment

- Validation of the EM
- Sensitivity studies
  - **Core radial mesh**, core axial mesh, Appendix K decay heat, axial power shape, break size, break orientation, **open barrel-baffle**

In-Vessel Deterministic: Review of LTCC EM

Uncertainty Analysis

- Important sources of uncertainty (e.g., ECCS Flow Rate, Injection Temperature)

Quality Assurance Program

- Analysis performed under STP’s QAP
- NRC was able to review the simulations

In-Vessel Deterministic: Summary

<u>Conservatisms / Simplifications</u>

- **full core blockage**
- **ignoring flow through the barrel-baffle region**
- **ignoring flow through the holes between the barrel-baffle region and the core**
- **biasing key input parameters conservatively**
- **using a conservative CCFL model and core modeling**

Simplified hot leg break simulation

Staff Review of STP GSI-191 LAR

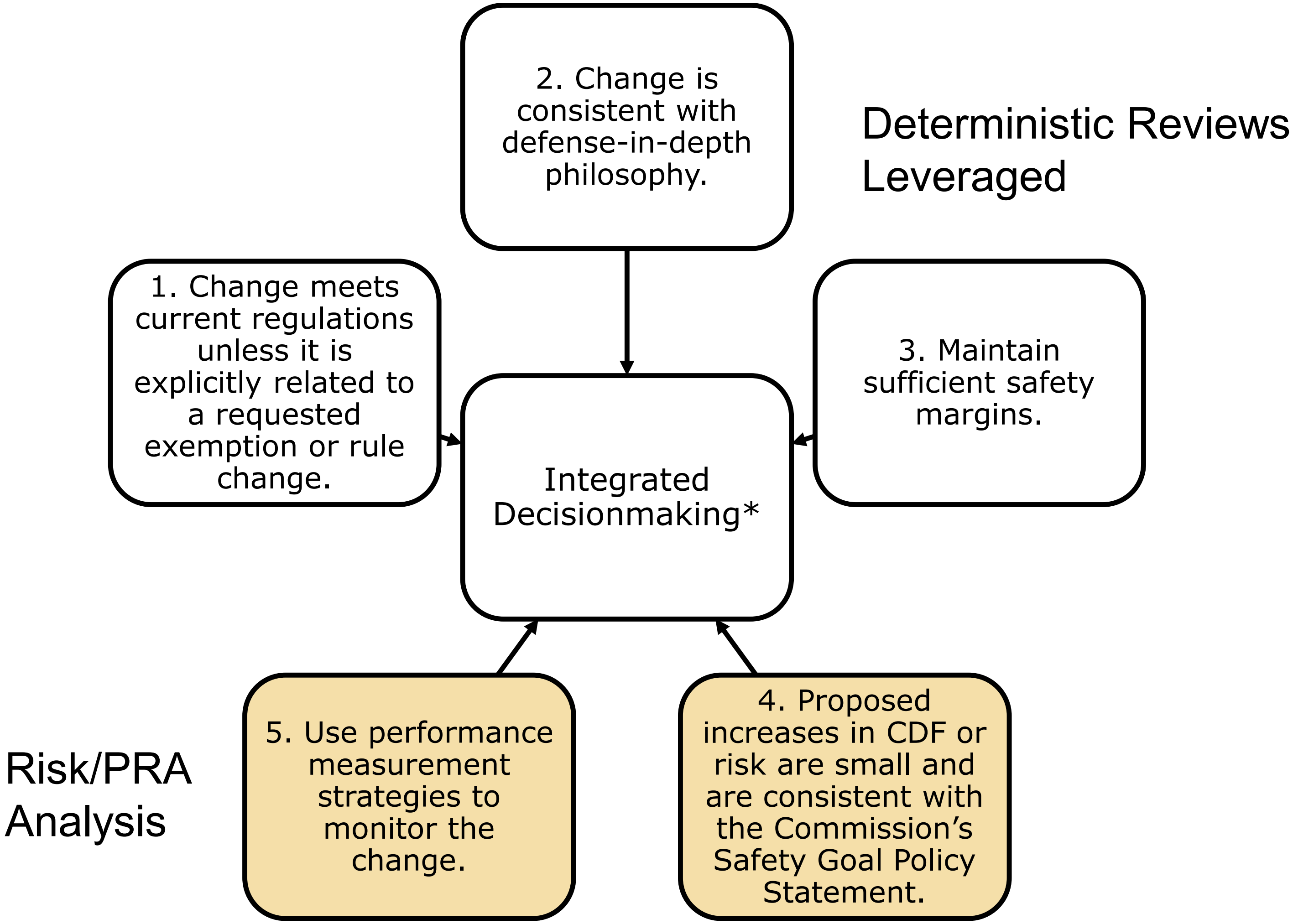
Principle 4: Risk
Principle 5: Performance Monitoring

CJ Fong, PE, Team Leader
Candace Pfefferkorn de Messieres, PhD, Reliability and Risk Analyst

Office of Nuclear Reactor Regulation
Division of Risk Assessment
Risk Informed Licensing

UNITED STATES NUCLEAR REGULATORY COMMISSION

Integrated Decisionmaking



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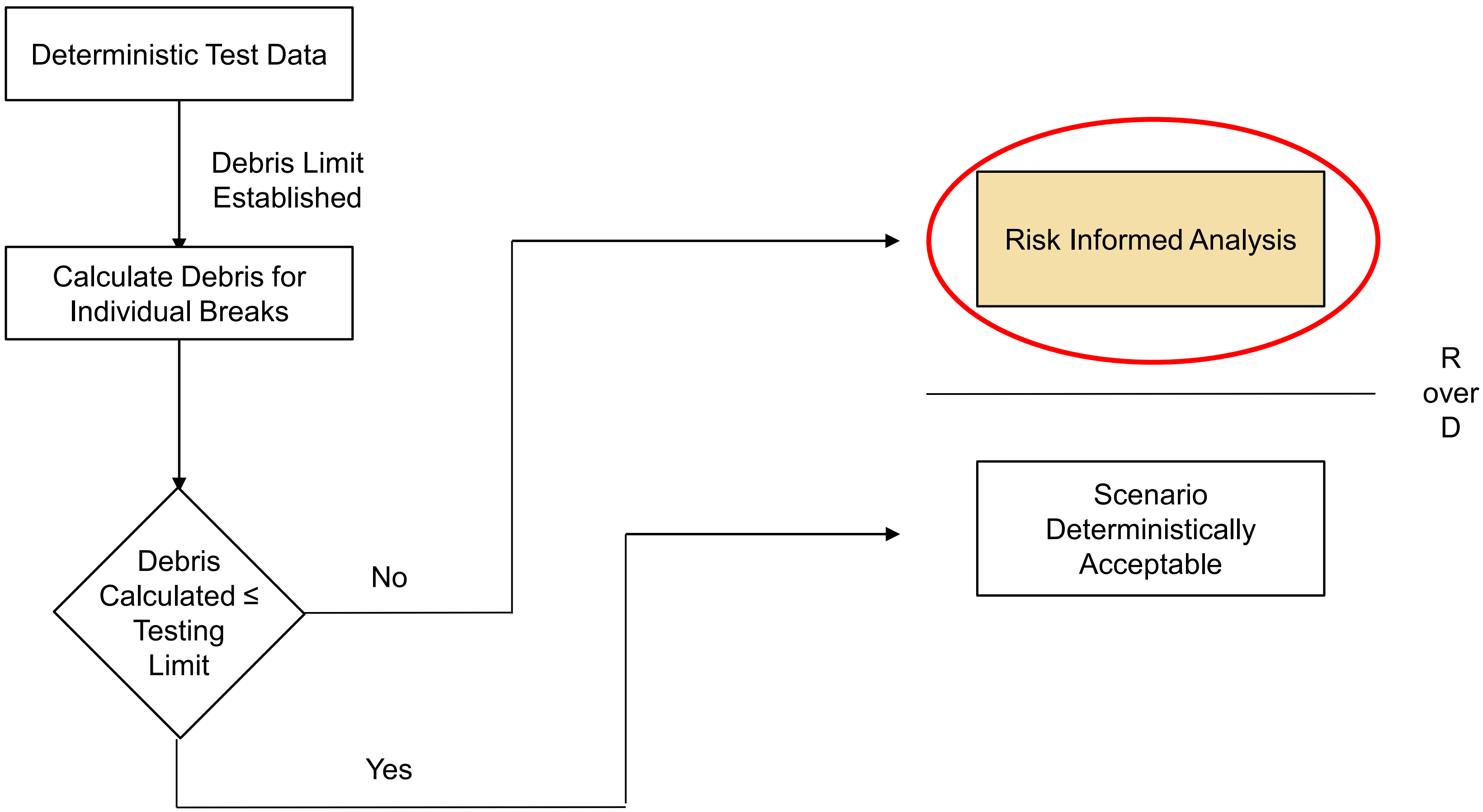
Risk over Deterministic Methodology



Principle 4
Proposed Risk Increases Are Small

- Review of the Base PRA Model
- Risk Analysis Approach
  - Scope of the Systematic Risk Assessment
  - Initiating Event Frequencies
  - Failure Mode Identification
  - Scenario Development
  - Systematic Risk Assessment
  - Sensitivity and Uncertainty Analyses

Staff addresses the use of non-consensus assumptions and models

The STPNOC Systematic Risk Assessment Key Assumptions

1. Considered both the geometric and arithmetic mean aggregation schemes
2. LOCA frequency allocated to various break locations according only to break size (e.g. “Top down”)
3. Considered complete vs. partial breaks.
   - In the “continuum break” assumption a complete break of a given size in one pipe is equally as likely as a partial break of the same size in a larger pipe.
   - In the “DEGB only” assumption, only complete, DEGBs were evaluated.

Staff Performed a Bounding Calculation to Evaluate all Key Assumptions

- Staff applied the conservative, upper bound approach presented to the ACRS during discussions on draft RG 1.229*

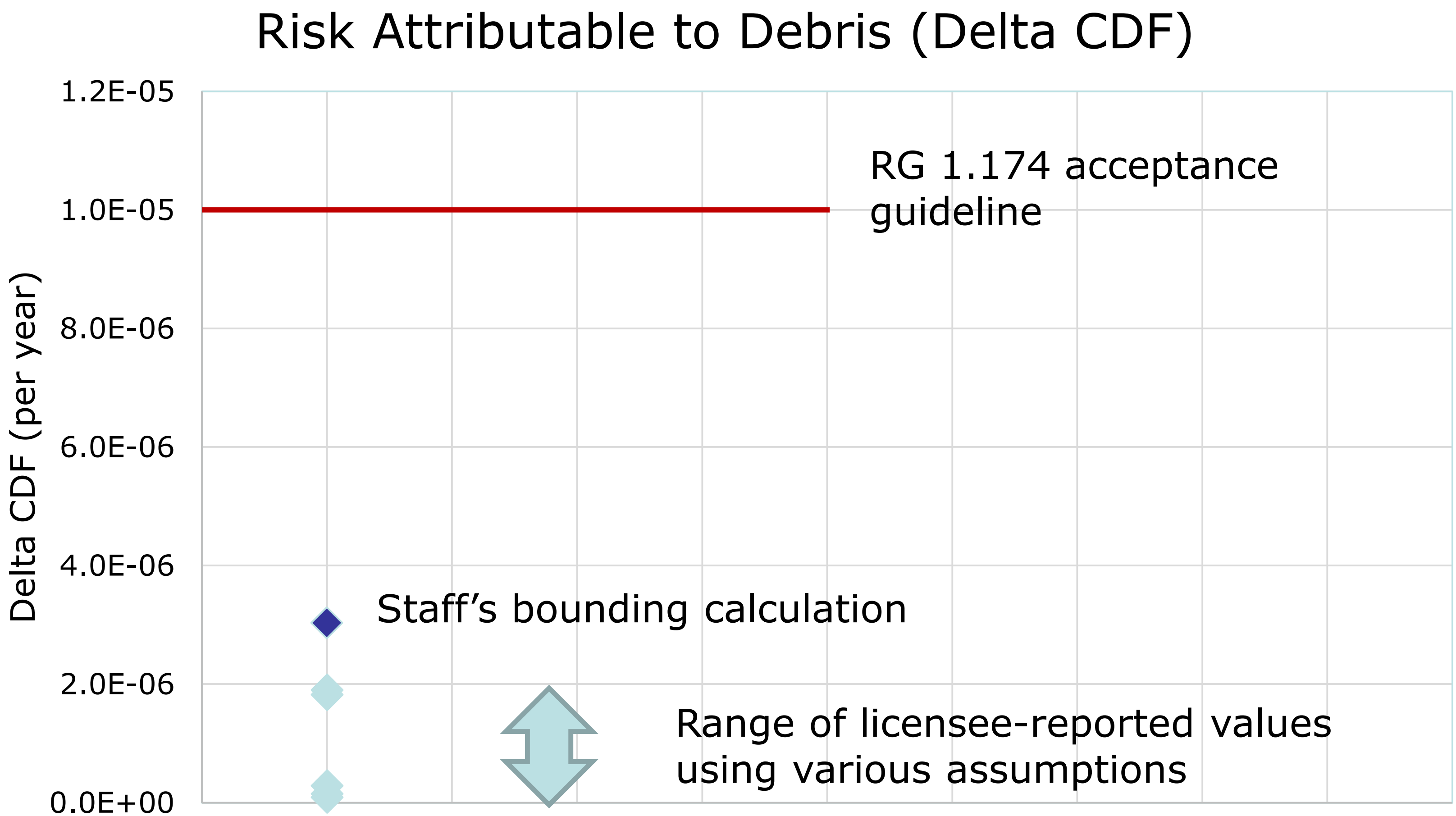
$$\Delta CDF_{debris} = f(x_{min})$$

$$x_{min} = \text{smallest critical break size}$$

$$f(x_{min}) = \text{exceedance frequency using arithmetic mean}$$

* ACRS Meeting April 7, 2016 (ADAMS ML16110A150)

Staff Explored Various Models and Assumptions when Evaluating Risk



* "Risk attributable to debris":
(Risk of as-built, as-operated plant) – (Risk of hypothetical "clean plant")

Principle 4
Summary of Key Criteria

- The licensee PRA is of the appropriate scope, level of detail, and technical adequacy.
- The risk-informed approach used by the licensee to address the effects of debris on long-term core cooling is consistent with approved practices.
- The increase in risk meets the risk acceptance guidelines as defined RG 1.174.

Principle 5
Performance Monitoring

- Risk analysis reviewed/updated every 48 months
- Procedures/controls have been developed to prevent/mitigate debris in containment (e.g. new TS and programs)
- NRC is notified if acceptance guidelines exceeded
- STP licensing basis (UFSAR) will specify key methods and assumptions that impact results

Principles 4 and 5 Summary

- STPNOC appropriately identified the scenarios that contribute to the increase in risk due to debris (ΔCDF_{debris}, $\Delta LERF_{debris}$)
- There is a lack of consensus for some assumptions in STPNOC's risk calculations
- Bounding calculation addresses lack of consensus and provides confidence that risk is within acceptance guidelines
- Performance monitoring approach is consistent with NRC guidance

Summary

- STP acceptably evaluated the impact of debris
- STP appropriately considered both risk and deterministic aspects in the submittal
- Most break scenarios are addressed using conservative deterministic methods
- STP's LTCC evaluation method and simulations are conservative and meet acceptance criteria
- STP's debris analyses meet the key principles of risk-informed regulation
- STP's PRA results show that the change in risk is very small