# Official Transcript of Proceedings

# NUCLEAR REGULATORY COMMISSION

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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676TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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OPEN SESSION

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TUESDAY, JULY 21, 2020

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The Advisory Committee met via Video-Teleconference, at 9:30 a.m. EDT, Matthew W. Sunseri, Chairman, presiding.

COMMITTEE MEMBERS:

MATTHEW W. SUNSERI, Chairman

JOY L. REMPE, Vice Chairman

WALTER L. KIRCHNER, Member--at-large

RONALD G. BALLINGER, Member

DENNIS BLEY, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

JOSE MARCH-LEUBA, Member

DAVID A. PETTI, Member

PETER RICCARDELLA, Member

ACRS CONSULTANT:
MICHAEL CORRADINI
STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:
MICHAEL SNODDERLY
CHRISTOPHER BROWN
CHRISTIANA LUI
QUYNH NGUYEN
WEIDONG WANG

ALSO PRESENT:
BRUCE BAVOL, NRR
ANNA BRADFORD, NRR
PROSANTA CHOWDHURY, NRR
MICHAEL DUDEK, NRR
MARIELIZ JOHNSON, NRR
MICHAEL MELTON, NuScale
SCOTT MOORE, Executive Director, ACRS
RYAN NOLAN, NRR
ZACKARY RAD, NuScale
DINESH TANEJA, NRR
PETER YARSKY, RES

P R O C E E D I N G S

(9:31 a.m.)

CHAIR SUNSERI: It is 9:31. We will now call the meeting to order.

This is the first day of the 676th Meeting of the Advisory Committee on Reactor Safeguards. I'm Matthew Sunseri, the Chair of the ACRS.

Members in attendance today, and I'm going to call the roll. Ron Ballinger.

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley.

MEMBER BLEY: Here.

CHAIR SUNSERI: Charles Brown.

MEMBER BROWN: Here.

CHAIR SUNSERI: Vesna Dimitrijevic.

MEMBER DIMITRIJEVIC: Here.

CHAIR SUNSERI: Walt Kirchner.

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba.

MEMBER MARCH-LEUBA: Here.

CHAIR SUNSERI: Dave Petti.

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe.

(No response.)

CHAIR SUNSERI: And Peter Riccardella.

MEMBER RICCARDELLA: I'm here.

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: And myself.

So, we have full attendance and a quorum.

The ACRS was established by the Atomic Energy Act. It's governed by the Federal Advisory Committee Act. The ACRS section of the USNRC public website provides information about the history of the ACRS and provides documents such as our charter, bylaws, Federal Register Notices for meetings, letter reports, and transcripts of all full and subcommittee meetings, including all slides presented at the meetings.

The committee provides its advice on safety matters to the Commission through its publicly-available letter reports.

The Federal Register Notice announcing this meeting was published on June 15th, 2020, and provides an agenda and instructions for interested parties to provide written documents or request opportunities to address the committee.

The designated federal official for this meeting is Mr. Mike Snodderly.

During this week's meeting the committee will take up the NuScale design certification application.

Our original agenda had the BWRX-300 topic on here. At the request of the committee, and with concurrence from staff and GE, General Electric-Hitachi, we have deferred that presentation until September full committee meeting. That will allow us to give them our full attention when they make their presentation, and it will allow us to give our full attention to NuScale during this set of meetings.

So, the progression of this meeting this week will start out with an opportunity for NuScale to provide some comments before we get into any further deliberation today. And that will be followed by staff with follow-up comments.

We may go into closed session to protect information designated sensitive or proprietary following that.

Once we get through those initial deliberations, then we will begin report preparation,.

The transcript will be kept until the point at which we begin our report preparation.

A bridge line has been kept -- a bridge line has been opened to allow members of the public to listen in on the presentation and committee discussion. We have received no written comments or requests to make oral statements from the members of the public regarding this week's sessions.

There will be an opportunity for public comment, and we have set aside time in the agenda for comments from members of the public who are listening to our meetings. Any written comments may be forwarded to Mr. Mike Snodderly, the designated federal official.

Since we are keeping a transcript, it is requested that speakers identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

And, as always, since we are conducting this meeting via Skype, we ask that all participants who are not speaking to mute your microphones because it just creates unnecessary distractions with all the background noise that can come across, and it affects the bandwidth of the transmission, which causes sometimes delays in the meeting because of interruption of the signal. So, we appreciate your support of that request.

At that time I don't have any other opening remarks. So, I'm going to, I guess, at this point I'm going to -- I'm going to call for a 5-minute recess at this point to allow myself to consult with the executive director before we go forward.

So, it's 9:36. We will reconvene at we'll say a quarter till, 9:45 to reconvene.

We are recessed. Thank you.

(Whereupon, the above-entitled matter went off the record at 9:36 a.m. and resumed at 9:45 a.m.)

CHAIR SUNSERI: Okay. This is Matt Sunseri, Chairman of the ACRS. We are going to reconvene. It's 9:45.

I will begin once again with a roll call.

Ron Ballinger.

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley.

MEMBER BLEY: Here.

CHAIR SUNSERI: Charles Brown.

MEMBER BROWN: Here.

CHAIR SUNSERI: Vesna Dimitrijevic.

MEMBER DIMITRIJEVIC: Here.

CHAIR SUNSERI: Walt Kirchner.

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba.

MEMBER MARCH-LEUBA: Here.

CHAIR SUNSERI: Dave Petti.

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe.

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: Pete Riccardella.

MEMBER RICCARDELLA: I'm here.

CHAIR SUNSERI: Okay. So, we're all back. And I apologize for that delay. I had some conduct of meeting protocol that I had to discuss with Scott. But we are, we are good to go.

And at this point, Walt, do you have anything --

MEMBER KIRCHNER: Yes, sir.

CHAIR SUNSERI: -- today as chair of the subcommittee?

MEMBER KIRCHNER: Yes, Mr. Chairman. Thank you. Good morning, everyone.

We have three pieces of business in front of us. But before we get to that, in the form of letter writing we have a letter that we're going to consider on boron redistribution, and specifically on the topic of boron dilution in the downcomer of the NuScale design.

We have a second letter that I call the final letter. That would be our recommendation of the committee on the DCA application. And now we have a slight amendment, so to speak, to that in the form of considering a standard design authorization as well.

And, thirdly, we have a very rough draft letter that we might get to later in the week to consider, and that is observations and lessons learned from our NuScale review.

So, that is the major business in front of us. But, before that, I believe we're going to hear from the staff about the request from NuScale to consider -- or, actually, NuScale has submitted a standard design application. So, we'll do that.

We then, I believe, should take, gather any other information that we feel is necessary for preparation of our letter reports because once we transition to letter reports, then the deliberations are amongst the committee, and the requests for staff support or other input from the applicant is then -- should only then be a matter of factual corrections and such, and not evolve into a situation where they're participating in the letter writing.

So, with that, I think at this juncture we should turn to the staff. And I don't know if that's Anna Bradford who is going to lead off or --

CHAIR SUNSERI: Walt, NuScale. I think NuScale is going.

MEMBER KIRCHNER: NuScale first. Okay, sorry, my mistake. Thank you, Mr. Chairman.

Yes, first a statement from NuScale and then we'll proceed to the staff. Thank you.

From NuScale?

MR. MELTON: Yes, sir. Mike Melton, Manager of Licensing. Ready to go.

MEMBER KIRCHNER: Go ahead, Mike.

MR. MELTON: Okay, thank you. And good morning, all.

Yes, so the purpose of this first discussion is to make a notification that NuScale has submitted a letter on the docket on July 13th. And the purpose of this letter is to request approval of the NuScale design as described in the NuScale DCA under Subpart Echo of standard design approvals covered in 10 CFR Part 52, upon completion of the staff's review and issuance of the final safety evaluation report; issuance of the SDA document, completion of the staff and the ACRS' technical review of the NuScale power small module reactor design.

The technical review of the NuScale DCA encompasses requirements for review of SDA application set forth in 10 CFR 52.139, Standards for Review of Applications.

In order to complete this process, NuScale also requests that the Advisory Committee on Reactor

Safeguards consider the same docketed and reviewed information as a basis for issuing a report pursuant to 10 CFR 52.53. I believe that's your final letter. And also include 10 CFR 52.141 for the NuScale SDA.

What we understand is, this is part of our approval process and, therefore, the reason for the letter at this time and this juncture in the review.

Any questions for us, please?

VICE CHAIR REMPE: I have a small question just out of curiosity. Your letter requesting the SDA was dated February 24th, 2020. Why is this coming up on July 13th in your second letter? Did something change where you planned to do it further out and now it's earlier?

MR. RAD: I can answer that one.

MR. MELTON: Yes. Essentially it was a course correction.

Okay, Zack. I will turn it over to Zack at this point. Thank you.

MR. RAD: So, yes, Joy. Thank you. This is Zack Rad, NuScale Power. I'm the Director of Regulatory Affairs, for the record.

So, the timing of this was simply a misperception on our part. We had anticipated actually submitting this closer to or even following the staff's FSER. And we were corrected on the need for the timing prior to the ACRS' final letter. That's all.

So, we had an internal misunderstanding of the timing.

VICE CHAIR REMPE: Thank you.

CHAIR SUNSERI: Members, further questions on the SDA from NuScale?

MEMBER PETTI: This is Dave Petti. We need to have reflected -- we need to reflect this in our 52.53 letter?

CHAIR SUNSERI: Yes, that's correct.

MEMBER PETTI: Okay, thanks.

MEMBER BALLINGER: Yeah, this is Ron. We did exactly this for the APR1400. It was very straightforward, just some additional wording.

MR. DUDEK: So, this is Michael Dudek. Can I -- did someone present for the NRC? I was on a phone call with Larry Burkhart on the back channel.

CHAIR SUNSERI: Michael, we haven't got to the staff yet.

MR. DUDEK: Okay, fine.

CHAIR SUNSERI: So, your turn's coming up in just a moment.

MR. DUDEK: All right. My apologies for

interjecting.

CHAIR SUNSERI: So, members, any further questions on the SDA of the applicant?

(No response.)

CHAIR SUNSERI: Hearing none, then let me turn to the staff on this topic.

MR. DUDEK: So, this is Michael Dudek.

I understand that this has been a little bit of confusion because we just got a letter on July 13th on NuScale formally submitting the SDA for NRC review.

Now, I'd like to just go back to a little bit of background information. In December of 2016, NuScale submitted a design certification application for its design. NRC staff reviewed that DCA application which contains information that also supports the NuScale standard design approval.

A standard certified design is codified by rule.

A standard design approval is a staff approval and is not codified by rule.

The FSER for the DCA when it is completed will present the staff's evaluation and findings concerning the NuScale standard design.

By letter dated February 24th, 2020,

NuScale notified the NRC staff of NuScale's intent to request a standard design approval in accordance with 10 CFR Part 52 Subpart E. NuScale SDA is based on NuScale's DCA design. NuScale also informed the NRC of its plans to seek review approval of an SDA application content not specifically required by Subpart E.

Now, this new letter, dated July 13th, 2020, NuScale formally submitted its standard design approval for the NRC's review. We immediately sent that over to the ACRS so that it could be incorporated into this meeting.

The SDA is similar to and contains part of the NuScale design as described in the NuScale DCA under Subpart E, Standard Design Approvals of Part 52. And upon completion of the staff's review and issuance of the final safety evaluation FSER, the contents of the application will be made public and we will move that forward.

The NRC staff, since that submittal of the July 13th letter, has confirmed that the DCA and its references contain the design information that Subpart E of 10 CFR Part 52 requires for the standard design approval. And we have incorporated that information into FSER Chapter 1, which includes -- now includes a reference to NuScale's July 13th, 2020 SDA request.

And this new SDA comprises a subset of the DCA requirements.

And based on that review of DCA application and what we need for the SDA, the staff concludes that the information in the DCA about NuScale's design complies with the requirements of Subpart E of Part 52.

The NRC staff also finds that the application for request for approval of the SD application, not specifically required by Subpart E, is acceptable.

And going forward, we seek acknowledgment from the committee that the SDA is in process and will be, potentially be approved by the NRC staff. And the NRC staff will move forward after this meeting and publish its determination in the Federal Register as to whether or not the design is acceptable, subject to the appropriate terms and conditions.

I think you've all seen the table for the comparison of Subpart E and the SDA. Staff has reviewed that and the delta therein, and has made that finding.

So, with that said, I open it up to any comments that the committee has.

CHAIR SUNSERI: Members of the committee?

VICE CHAIR REMPE: So, this is Joy. If I could ask a couple of questions of the staff.

CHAIR SUNSERI: Go ahead.

VICE CHAIR REMPE: First, I'm curious with all the carve-out associated with the DCA for the NuScale design and how the staff, and when have they ever had carve-outs in a situation like this? It did not occur with the APR1400, and how the staff would deal with the carve-outs if someone were to move on the SDA before the rule occurred?

And the other question I have is, and I was looking to this table where it talks about intended use of the reactor, there has been some noise with the MOU that the DOE has regarding the U.S. reactor that one of the two modules will be used for testing. And how would that be dealt with with the SDA if something were to be progressing with the design based on this SDA?

Now, I do know they were talking about a power upgrade and all these other things that are beyond. I'm pretending that you're going to use the SDA as it is, go forward, start doing construction with it, and then someone says, well, okay, we'd like to do testing with it. Can the staff talk about that as well as the carve-out issue, please?

MR. DUDEK: So, I can address the first. And I think, and I may need help with the second piece.

But from what I've gleaned from my staff, and in talking to the APR1400 owner -- and this was brought up during that time about carve-outs and exemptions -- I think our letter and our Federal Register Notice will have to acknowledge both the exemptions and the carve-outs as being unique for this certified design.

I think we are still looking into that and seeking OGC insights on that. But I assure you we will iron that out.

And remember, as for the second, the SDA, the snapshot on time on the certified design. So, I think, Anna, do you have any insights on the testing or using it for the second part of Joy's question?

MS. BRADFORD: Hi. This is Anna Bradford from NRR. Yeah, one.

One thing just to add to what Mike just said about the SDA and the carve-outs. I mean, a simple way to think of it is if it's not approved in the certification, it's not approved in the SDA. Right?

So, if we have not made a determination on something in the design certifications phase, we also will not have made a determination on that in the SDA space. They go hand in hand.

The testing part, we have not, I will say, officially heard from UAMPS that that's their intention or how they would go about it or how they would want the licensing for that to work. So, I'm not sure we can answer that question yet.

VICE CHAIR REMPE: Okay. That helps.

And I, again, if they have a carve-out, and let's be real optimistic and say they're going to have not only a UAMPS one with this carve-out, and they also are going to have one at TVA at their site, the first person who comes in is the applicant to deal with it on the UAMPS side may have one way of dealing with it, and the staff approves it. But then the second application with the SDA at a different site may deal with it differently, but the staff each time would evaluate it.

Is that true?

MS. BRADFORD: Yes. That is correct.

VICE CHAIR REMPE: That helps. Thank you very much.

CHAIR SUNSERI: This is Matt. Sorry for

this question. I mean, I'm kind of a governance-minded guy here and I'm just a little unclear on the governance right this moment here.

So, let me ask a question. This is for Michael Dudek. Maybe Anna can chime in on this.

But, so where is -- so, the ACRS, we are an advisory committee. We don't approve the SDA, we recommend approval, or whatever we're going to recommend on these things. And we do that based on review of the staff's work.

So, is the staff's work on the SDA going to be sufficiently complete and have a finding such that we can, you know, agree or disagree on that finding, I guess, or advise on that finding?

MR. DUDEK: Yes. Can I --

CHAIR SUNSERI: Is this what you're about to say here? You just got this information on the 13th, and I don't know, have you updated all your documents and, you know, got that, what's going to be before us properly so we can do our role?

MR. DUDEK: Yes. So, the project manager has appropriately updated Chapter 1. And that's what I was discussing with Larry Burkhart is kind of the nuts and the bolts of the approval of that chapter.

We have sent you the updated chapter.

However, I have not -- we have not officially declared that in ADAMS yet. So, Larry Burkhart and I were discussing the finer points of how we were going to get that done.

But, yes, the finding has been updated in Chapter 1. And we have essentially made that finding.

CHAIR SUNSERI: It was looking --

MS. BRADFORD: So, this is Anna Bradford.

CHAIR SUNSERI: -- at the process though, right, so that's what you were saying?

MR. DUDEK: I'm sorry, I didn't hear your question, sir.

CHAIR SUNSERI: So, what I thought I -- so, if I understand what you were saying, though, the safety evaluation report has been updated but it hasn't gone through all its final approvals yet. Is that accurate?

MR. DUDEK: That is correct.

CHAIR SUNSERI: Okay, thank you.

MEMBER KIRCHNER: Mike. Michael, this is Walt Kirchner. Do you have an estimate about how much time that would take you?

MS. BRADFORD: Can I jump in here for one, can I jump in here for one second?

MEMBER KIRCHNER: Yes. Go ahead, Anna.

MS. BRADFORD: Thank you.

I just want to make it clear this is almost just an administrative check. I mean, it's not change -- we're revising Chapter 1 of the SE to say that we've made findings under the SDA portion of the regs. But it is not going to change the technical content of our SE.

You can think of it as sort of the SDA is encompassed by the design certification review. So, really it's almost just changing a few sentences in Chapter 1, which is the introductory part, to say we have looked at it under the requirements of the SDA and this is okay.

But, I don't want to leave you with the impression that we're going back and changing, you know, large numbers of chapters of the SE or anything like that. When you ask for a schedule that's not what this entails.

CHAIR SUNSERI: Yes. Thanks for that update, Anna.

MEMBER KIRCHNER: Yes. Thank you, Anna. Because I was going to pose a question just for the public record along those lines that this doesn't require a substantive change to the FSER. It will be reflected in Chapter 1.

MS. BRADFORD: Correct.

CHAIR SUNSERI: Yes. But, Walt, so, I mean, my question though, my committee concern might be is this: so, let's say that, you know, we end up the week and we write a letter and we say -- and I'm just forecasting, I'm not saying this is what the letter is going to say or not -- but let's just say we come to the conclusion that we recommend the DCA and the SDA be approved. Okay. But the SER hasn't been finalized and we haven't gone through all the stuff, and we haven't seen the final. (Phone rings.) -- a reason as quickly as this came up it goes away and you end up not approving the SDA, and then we're out on the record having said we recommend you approve it.

So, I guess technically then you could say, well, we didn't approve it so your recommendation is still good. I don't know. I just seems awkward to me.

MEMBER KIRCHNER: Yes, I agree. That's why I was asking Michael what an estimated completion date is for filing that FSER so that we're not out there ahead of them, so to speak, in our recommendations.

MR. DUDEK: So, if I could, I think this meeting has been proposed to span a couple of days.

I think we have the opportunity to work with the PM and to work with the staff on trying to get that document finalized. And when we do, we can let you know, and we can keep you updated as this meeting progresses.

MEMBER KIRCHNER: Okay. And then we'll trust but verify.

MR. DUDEK: Correct.

MEMBER KIRCHNER: It will take us time to get our official letter out as well. As long as we're not looking at a process that goes on for several months with regard to the SDA.

MR. DUDEK: I think we're looking at days, a week at the most. So, I think we could be -- we could have that, that final ML number to you in short, in the relatively short term.

MEMBER BROWN: What does that mean?

MR. DUDEK: We could have that Chapter 1 done in fairly short term, maybe days or within a week or so. So what, by the time this letter, your letter is finalized you will -- I would hope that the staff would be able to have that information to you.

MEMBER BROWN: We're finalizing the letter this week, aren't we, Matt, Walt?

MEMBER KIRCHNER: That's for our

deliberations. But there is a process that we go through, Charlie. And the chairman, our committee, can hold the letter until he is satisfied that due process has been, or due diligence has been observed on our part and that this has, the FSER Chapter 1 has been completed.

MEMBER BROWN: Yeah, I understand. I understand that part, Walt. I'm just trying to connect, this, is this SDA strictly for UAMPS or does it apply to anybody else that comes in?

MS. BRADFORD: So, this is Anna Bradford again.

The SDA is just a generic licensing finding, I'll say. So, no, it's not just UAMPS. Someone else could refer to it in a future application if they wanted to.

MEMBER BROWN: Does that mean -- I'm still trying to get a grip on it. I'm sorry I'm so, so short on this.

Effectively, it doesn't change the certified design. They can't change the certified design at all as a result of an SDA?

MS. BRADFORD: In this case, in this case the scope of the SDA and the scope of the DC are pretty much the same.

MEMBER BROWN: What does that mean? What's "pretty much" --

MS. BRADFORD: The design, the design that we're approving in the SDA is the same as the design that we're approving in the design certification. There's not a difference in the design, it's the same thing.

It's almost a different piece, just a different piece of paper that we're giving them to say we've completed our technical review and we find the design acceptable.

MEMBER BROWN: Okay. So, I'm going to be parochial here for a minute. We have part of the DCA and the SER and all of the design certification documents. There's a Chapter 7 which describes all the reactor trip safeguards and the rest of the architecture for all those systems, control systems. Yes, --

MR. DUDEK: So, to answer your question, the certified design will not be changed. The SDA can encompass more information than the certified design but it cannot encompass less.

MEMBER BROWN: It's not a matter of encompassing, it's a matter of can they change the architecture for the trip systems and the safeguard systems when they are applying an SDA? Or does it have to remain --

MS. BRADFORD: Only if they --

MEMBER BROWN: -- what's described in the DCA as we certified it, as we write our letter on it?

MS. BRADFORD: So, this is Anna Bradford from NRR again.

Remember, it's technically not certified until the rulemaking is done. So, a lot of applicants don't want to wait that six to nine months for the rulemaking to be done, so they ask for an SDA to be issued at the end of our technical review, which is now.

So, what the SDA is, is it provides them some formal feedback from the regulator that we looked at your design and it's okay. If someone then wants to refer to that SDA in a future application and they want to change something, they would need to come back and talk to us about that.

MEMBER BALLINGER: This is Ron.

With the APR1400 it really boiled down to time in the sense that with the SDA you really have approval, in effect, but the final rule takes, like Anna said, I think six to nine months. And so, it's really a matter of timing.

MEMBER BROWN: Ron, I understand that part of it on the timing now that it was pointed out. My only real question, and I've asked it but I haven't gotten a no to it, is that fundamentally what we have reflected in Chapter 7 has to be reflected in whatever design, regardless of somebody's desire to use an SDA prior to the rulemaking.

The rulemaking contains something. I mean, if somebody decided to come back, I guess the rule could say, hey, we're going to change part of the DCA, I presume.

MS. BRADFORD: In either case, if a future applicant was referring to the SDA or the certified design they can propose to do a different approach or do something different, and then the staff would review that.

MEMBER BROWN: I got that. That part I pretty much understand.

MS. BRADFORD: Okay.

MEMBER BALLINGER: Okay. I just find it hard to write all this.

MEMBER KIRCHNER: Other members?

MEMBER BROWN: I was just trying to get a hold on this. That's all. I'll quit.

MEMBER KIRCHNER: Charlie, are you

satisfied?

MEMBER BROWN: My stomach is rolling over. How about that?

MR. DUDEK: So, I think I can, very hopefully, more clearly answer your question.

The SDA as it's going to be approved will not change anything in the certified design. So, Chapter 7 will remain the same. And does that --

MEMBER BROWN: Okay. I went through your table and every item in it. That's what my concern, that's what my thought was until I started hearing this conversation. I thought it changed nothing at all. It effectively changed acronyms and a few other administrative missing lights.

So, I'll, I'll say I'm satisfied so we can walk off right now. I'm sorry for the delay.

MEMBER KIRCHNER: No, that's fine, Charlie. It's better to have this, thrash it out now than when we're in the letter writing phase.

Other members?

MEMBER BLEY: This is Dennis Bley.

It seems to me that when we get through our letter writing we can, as we have a motion to approve the letter we can include authorization for our chairman to either withhold it or remove a sentence that refers to the design approval if it's not in place by the time we're ready to issue the letter. But we can address that at the end of our letter writing.

MEMBER KIRCHNER: Thank you, Dennis. That was my thinking as well. So, there's a way for us to address Matt's governance question.

Other members?

MEMBER DIMITRIJEVIC: Well, you know, I'm sort of reasoning will there be a change in the language for carve-outs? Because we will have to reference those carve-outs in our letter. Will that be different language now?

MS. BRADFORD: So, this is Anna Bradford from the NRR.

I think it might be worded different because the SDA is not a rulemaking, so the language of the carve-out would not say, you know, --

MEMBER DIMITRIJEVIC: Right.

MS. BRADFORD: -- this information is not receiving finality in the rule. But the technical description would stay the same.

MEMBER DIMITRIJEVIC: Yeah, it can be --

MS. BRADFORD: The carve-outs -- Go ahead. I'm sorry.

MEMBER DIMITRIJEVIC: Then it's okay because that will be language we will need to put in our final letter. So, it will be good to have the final, you know, language on this is how it's going to be in the SDA.

MEMBER BLEY: This is Dennis Bley again.

Anna, maybe this would help. Can you tell us what an applicant, well, the holder would be able to do, what can you do differently with a design cert than with a standard design approval? And that might help.

MS. BRADFORD: That's a good question.

So, a design certification is afforded much more finality by the agency, so that once it's completed the rulemaking it is final and it's very difficult for us to change it.

An SDA has less finality from the agency and, therefore, gives future applicants less certainty that nothing in it could be revised.

I don't know if that helps. But an SDA is more open to changes being required by the regulator in the future than a design certification is.

VICE CHAIR REMPE: But isn't there a bit more you can do with it, because the rule won't come out for a while? And if you have a staff-approved

SDA, can't you go ahead and try and seek your construction permit, for example?

MS. BRADFORD: Sure. Yes, you absolutely could. But when the applicant comes in for that construction permit and they refer to the SDA, our findings in that SDA do not have the level of finality that our findings will eventually have in the design certification.

It's almost like you could think that since the design certification is a rule, and an SD -- you can almost figure that the way we talk about rules and guidance, so rules have a certain level of requirements and you must conform with them, and then we have guidance. And it's more like that's one way you could do it. But the agency might look at another way.

I think of it that way. The design certification is a rule, it is locked down in terms of finality. An SDA does not have that same level of finality.

MEMBER BROWN: Can I phrase that? The DCA you're waiting on the rule to come out six to nine months. That's what you said. Takes time.

If somebody proceeds with an SDA, they are in a way taking a risk that there will be no change when the rule comes out?

MS. BRADFORD: That is true, yes.

MEMBER BROWN: So that is a risk, it's a risk, if they're willing to take that risk on the assumption that the DCA, as final as it is, is not going to make any changes or nothing comes up in that 9-month period. So, it allows them to get started, even though the finality that you talk about has not been granted.

MS. BRADFORD: Correct.

MEMBER BROWN: Okay. Now I've got a, I've got a better understanding of what you're talking. It's really, it's really a risk by the guy that gets started before he knows whether he's going to be okay or not, if he wants to. That I can --

(Simultaneous speaking.)

MS. BRADFORD: No, I think that that is definitely one way to think about it. It does not have the same finality as if you waited nine more months for the rule.

MEMBER BROWN: I'm trying to put it in perspective for what I used to have to deal with back in my day in NR. Frequently our vendors would proceed with a design change based on meetings we had. I had to write a letter saying that's what to do to get it through. But they would proceed, proceed in the hopes that we didn't tell them to do some tweak on it in order to keep moving. So, that's the way I view this thing, the SDA application.

MEMBER BLEY: Anna, it's Dennis Bley again. You talked about this earlier, but as this talk goes on I want to revisit one part.

Your SER, will it, will it -- will there be a separate SER for the design approval or will it just be referred? This is going back to the carve-outs. You recommended carve-outs in your SER for the design cert which will end up, if the Commission approves, as part of the rule.

How do those carve-outs, how are they retained as part of your design approval?

MS. BRADFORD: So, the question you just asked is important. There is not a separate SE for the SDA. The SDA and the design certification are based on the same SE. So, there's not a separate document.

The only separate document --

MEMBER BLEY: So the carve-out is still there?

MS. BRADFORD: Yes. But if you go back and look -- and we can send it to you if you don't have it readily accessible -- the only thing we issue, that the agency issues for an SDA is a letter that's, like, two or three pages. And we send that to the applicant and we say, you've met the requirements for the SDA. Our SE is at such and such. It's the same SE as for the design cert. And that's it, that's what they get.

MEMBER BLEY: Okay. That, that makes me much more comfortable. Thank you.

MS. BRADFORD: Sure.

CHAIR SUNSERI: Hey, Anna, this is Matt. I hate to keep bringing these questions up. But just one more question.

We're well versed in how a DCA, an approved DCA gets changed, the deviations and all that stuff. What is the change -- is there a 10 CFR 50.59-like process for the SDA?

MS. BRADFORD: I think that -- I don't think there's a 50.59-like process. I think what would happen is the applicant would come in and say that there's a COL applicant, and they want to refer to the SDA because they don't want to wait for the rulemaking.

In their COL application they would point out places where they want to deviate from the SDA and explain why they want to do that. And we would review that.

CHAIR SUNSERI: Oh, okay. Thank you, that's helpful. Appreciate it.

MEMBER KIRCHNER: Anna, this is Walt Kirchner. Just one last request.

All the proposed rule -- probably not using the right terminology when we say "carve-out" -- but all the proposed language that would be in the rule is currently in the FSER; is that correct?

MS. BRADFORD: The -- not the exact language. Like, this doesn't say necessarily, you know, this rule is not providing finality. But the technical discussion talks about areas where we couldn't reach a conclusion based on various things. So, it's all written up in the SE where we can find that.

MEMBER KIRCHNER: Would it be just so, since the SE is a rather large document, would it be too much to ask for a review, for your staff to just give us a pointer list of all the places where you have inserted that kind of language in the FSER?

MS. BRADFORD: The language that supports the carve-out?

MEMBER KIRCHNER: Yes.

MS. BRADFORD: Yes. We could do that.

MEMBER KIRCHNER: I'll be much obliged. That would help us ensure that we're complete in our review. Thank you.

MS. BRADFORD: Sure.

MEMBER KIRCHNER: Other members?

MEMBER DIMITRIJEVIC: This is Vesna Dimitrijevic again.

Do all the commitments, like COLA items, ISEC items, you know, the -- do those all apply equally?

MS. BRADFORD: So, the COLA items -- Let me back up.

The regulation for a COL application tell the COL applicant that they need to address the COL items. There is not something similar in the SDA regulations that say you have to address the COL item because it's an SDA not a COL.

But the COL items are documented in our SE. So, the staff would know, hey, here are things that we thought a future applicant would need to address. So, they would still all be on the record in our FSER about things that needed to be addressed by the future applicant, whether they're using the SDA or the design cert. If that makes sense.

MEMBER DIMITRIJEVIC: Okay.

MR. MOORE: Mr. Chairman, this is Scott Moore. May I address the committee?

CHAIR SUNSERI: Please do so, Scott.

MEMBER KIRCHNER: Yes, please go ahead.

MR. MOORE: So, I have a question for the committee.

Does the committee need any more information from the staff in order to write its final letter this week, in addition to what Chairman Kirchner just asked for?

VICE CHAIR REMPE: Well, I think we're going to hear from the answers to those questions, Scott; right? And the staff's going to be giving us information. So, we aren't sure yet; right?

MEMBER MARCH-LEUBA: One member of the committee -- this is Jose -- has technical questions I want to raise whenever I'm allowed.

MEMBER KIRCHNER: Yes.

MEMBER MARCH-LEUBA: I would like to get more information from them, yes.

MR. MOORE: Yes. They are going to go, I believe they are going to go through that this morning.

Anna, do you understand what the

committee's asking?

MS. BRADFORD: Yes.

MR. MOORE: Okay. Besides that, is the committee asking for any other information about the carve-outs in writing that you need this week?

MEMBER KIRCHNER: I don't believe so, Scott. It's just that such a list, a pointer list, would help us just be sure that we're complete in our work. That's, that's why I made that request of Anna Bradford.

MR. MOORE: Okay. And then for the staff, for Anna and Mike, just to be clear, the committee is doing letter writing this week on the final letter. And I think you heard that the letter then will be prepared. The committee would vote it out this week in one way or another, depending on what the letter says. And the chairman would sign out some final letter next week, in probably the middle to later part of next week.

So, it would need the staff's action on the SER by that point. Just to give you a sense of timing.

Thank you, Mr. Chairman. That's all I have to say.

MR. CHOWDHURY: Mr. Chairman, this is

Prosanta Chowdhury, Project Manager.

May I have a few seconds to clarify something that will be very helpful to the committee?

CHAIR SUNSERI: All right. Yes, please proceed. Yes.

MR. CHOWDHURY: Yes, okay. This is Prosanta Chowdhury. I'm Project Manager.

Referring back to the request for pointers to the carve-out, Chapter 1, the draft version that we have shared with the ACRS staff this morning, on page 1-3 of Chapter 1 has the pointers to all those carve-outs in one of the paragraphs.

CHAIR SUNSERI: Okay. Thank you, Prosanta, that's very useful. We'll take a look at it.

I did not look at the FSER this morning over breakfast, but we'll get to it. Thank you.

MR. CHOWDHURY: Conclusion of Chapter 1 also talks about, clearly identifies those carve-outs, but the pointers are on page 1-3.

CHAIR SUNSERI: Thank you very much.

MEMBER BLEY: Dennis Bley. One last thing.

CHAIR SUNSERI: Yes, Dennis, go ahead.

MEMBER BLEY: Between now and whenever you finish the letter I'd recommend to the members to read part -- Section E of Part 52 on standard design approval. It's really short and it will give you -- I think it will help. But it's a very short thing. You can read it in five minutes.

MEMBER BROWN: Did you say Section E or D, Dennis, of Part 52?

MEMBER BLEY: Echo, Standard Design Approval. If you go to Part 52, you can't miss it.

MEMBER BROWN: Okay, thank you.

CHAIR SUNSERI: Thank you, Dennis.

MEMBER KIRCHNER: Okay.

MR. DUDEK:. So, Mr. Chairman, Michael Dudek. Oh, go ahead.

MEMBER KIRCHNER: We could transition now. We had posed, Mr. Chairman, we had posed after our deliberations two weeks ago, we had several members pose questions of the staff. So, I think we are at that juncture in the proceedings to take on those questions.

CHAIR SUNSERI: Yes. And just want to confirm one thing. Did Michael Dudek want to make one more statement? I heard you trying to break in there.

MR. DUDEK: So, my apology. I didn't mean to break in. I just wanted to clarify whether we still had that as a formal IOU or not. Did Prosanta's clarification --

MEMBER KIRCHNER: I think that's sufficient, Mike. I don't want to send you on another chase. That helps.

MR. DUDEK: I understand. Thank you, sir.

MEMBER KIRCHNER: Thank you, Michael.

CHAIR SUNSERI: Okay, Walt, thanks for that. Yes, I agree.

So, do you want to, do you want to take a short break here for a few minutes before we get into the next section since we're kind of shifting gears then on the questions?

MEMBER KIRCHNER: Yes. That would be good, Matthew. If we could, Mr. Chairman, if we could take a 10-minute or 12-minute break and --

CHAIR SUNSERI: Yes.

MEMBER KIRCHNER: -- reconvene at, what, 10:40?

CHAIR SUNSERI: Well, I feel --

MEMBER KIRCHNER: 10:45?

CHAIR SUNSERI: Feel generous, yes, 10:45.

MEMBER KIRCHNER: Okay.

MR. SNODDERLY: Chairman Sunseri, this is Mike Snodderly. I just have one clarification for

Mike Dudek.

CHAIR SUNSERI: Sure.

MR. SNODDERLY: So, for the public record, eventually this transcript will be on the public website, and I just wanted to confirm with Mike Dudek that the table that you provided the committee comparing Subpart D and Subpart E, I plan to make that part of the record and attach it to the transcript. I just wanted to make sure that that's publicly available and that's okay to share that, that table comparison.

If not, please get back to me. But if I do not hear from you, I will add that to the record.

MR. DUDEK: I understand. And I will, I will get back to you.

MR. SNODDERLY: Thank you.

MEMBER KIRCHNER: Thank you, Mike, both Mikes. Thank you.

Okay, with the Chairman's permission, I think we are now recessed until 10:45 Eastern Time.

(Whereupon, the above-entitled matter went off the record at 10:29 a.m. and resumed at 10:45 a.m.)

CHAIR SUNSERI: This is Matt Sunseri. I have 10:45. We are back in session. I'll being with a roll call to confirm a quorum. Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley?

MEMBER BLEY: Here.

CHAIR SUNSERI: Charles Brown?

MEMBER BROWN: Here.

CHAIR SUNSERI: Vesna Dimitrijevic?

(No audible response.)

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Here.

CHAIR SUNSERI: Dave Petti?

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: I'm here.

CHAIR SUNSERI: And I'll go back to Vesna?

MEMBER DIMITRIJEVIC: Here. I'm here.

CHAIR SUNSERI: Okay. Thank you. All right. We have a quorum. And I would just start by saying thank you for the staff and NuScale's explanation of what was going on with the submittal of the SDA. We have a clear picture of what work is before us now for the rest of the week incorporating that request.

We are going to move on to the next phase of the discussion today which as you recall at our last round of meetings, we asked members to pose questions to staff that we would need to have addressed to finish our deliberation. Staff is now prepared to address those questions, and Walt and I have discussed the sequence of how this session is going to be conducted. So Walt is going to facilitate it, and I'll turn it over to Walt to describe how we're going to go about this. So Walt?

MEMBER KIRCHNER: Okay. So we would like to first hear from the staff addressing the questions that members had posed. When we do that, perhaps if the staff could just summarize the question and then provide their response because we're on public record. And then we'll go to deliberations and input from members.

Member March-Leuba has made a point that he would like to make a statement and we'll go from there and try and conclude our deliberations. If we need to or if the staff feels they need to go into closed session to fully address a question, then we should hold that to the end. So we only break from open to closed once. And then we would do whatever is necessary in closed session and then come back to open session and a while for any public input. So with that, I will now turn to the staff. Mike Snodderly, who from the staff is going to lead us through this?

MR. SNODDERLY: I believe Ryan Nolan of the staff. Is he available?

MR. NOLAN: Yeah, this is Ryan Nolan from the staff.

MEMBER KIRCHNER: Okay. Ryan, go ahead, please.

MR. NOLAN: Okay. This is Ryan Nolan from the staff. I'd like to thank you for the opportunity for the staff to provide responses to additional ACRS questions. I'm going to start with Member Bley's question and then we'll work back to the maybe the more specific area questions when I'm done.

So Member Bley's question is, what prevents the staff from asking how the operator will stop an unplanned dilution before the shutdown margin is eliminated as described in SRP Section 15.4.6. And it's titled, inadvertent decrease in boron concentration in the RCS for PWRs. Before I get into the specifics of that question, I just want to take a step back and just quickly maybe address at a high level operator actions and their role within passive designs.

And so NuScale performed their design basis Chapter 15 analysis, assuming no operation actions for a minimum of 72 hours. I think we have went over that many times at this point. This approach is consistent with the Commission policies for passive designs as well as industry guidance. So by definition, we would not consider the NuScale design to be passive if it required early operator action in order to respond to or mitigate a Chapter 15 event.

In addition, SECY-93-128 establishes the Commission policy that passive designs should be able to cope on site for all design basis events for at least seven days. So while previous passive designs needed operator action and nonsafety systems around the 72-hour mark to continue satisfying the safety functions, NuScale has demonstrated through their analysis that even up to seven days, operator actions are not needed to satisfy those safety functions.

I'd also like to point out that keep in mind that this is really just to establish the licensing basis for the facility. In contrast or in reality, this does not prevent the operators from following their operating procedures and taking action if needed. So I just wanted to provide a little bit of perspective on sort of the role of operator actions in passive design licensing.

Specific to the purpose of SRP 15.4.6, the purpose of that transient is to address the potential for unborated water addition to the RCS from external sources such as CVCS. As pointed out in the question, the 15.4.6 analysis typically must show that an operator can reasonably identify and stop the unplanned dilution before the shutdown margin is eliminated. This SRP and the guidance was really written for active plants, and so there's a lot of prescriptive sort of review procedure and a focus of, how long does it take the operator to identify or isolate before the shutdown margin is eliminated?

Because NuScale has passed their design, they demonstrated that the applicable regulatory requirements were met with the use of automatic safety actuation signals to isolate the largest source of unborated water which for them is the de-mineralized water system. And they showed that that isolation occurs before the shutdown margin is lost. And so for the purposes of this Chapter 15 analysis, NuScale showed that the SAFDLs were met. You didn't lose the shutdown margin, and no operator actions were needed.

Whereas I think the main focus of today's meeting as well as the last couple ACRS meetings is on the potential for an uneven boron distribution. But that's really due to the natural transient progression of extended passive cooling. And it's distinctly separate from the transient that's identified within Section 15.4.6.

I'll also note based on the analysis and our conclusions, any post-event thermohydraulic disruption to the RCS that would potentially impact those SAFDLs would require multiple failures or operator actions of commission. And that's why it was not addressed because it's outside -- it's not addressed within the design basis review because it's outside of the Chapter 15 analysis. That doesn't mean the staff didn't address that.

The misuse of nonsafety-related systems or multiple errors of commission is addressed within Chapter 19. And those conclusions are mainly supported by Dr. Yarsky's white paper which we discussed at the last meeting and I'm sure we'll be discussing it again today. But ultimately, what I'd like to point out is whether the SRP 15.4.6 is appropriate guidance to use for a boron redistribution analysis or for this phenomena.

The SRP is really there to identify what the applicable regulations are and how the staff would perform a review to demonstrate compliance with those regulations. And the regulations that are identified in 15.4.6 are the same regulations that we made findings on for the uneven boron distribution analysis. Mainly, GDC 10 for the SAFDLs is one of our main focuses here.

And so our conclusions for the uneven boron distribution is that even if you do get a diluted downcomer or containment and there's no operator actions, the SAFDLs are met for at least 72 hours, and then as documented in Chapter 19, likely beyond seven days if the operators don't do anything. And so I'll pause here to take any additional questions.

MEMBER BLEY: Good. This is Dennis Bley. That's a nice, elaborate answer. My question, you get a bit modified by the time it was presented to you, but you knew what it was about. But I'll state it again.

We've been told time -- many times during this review that recovery is reserved for the COL stage, and this would be a recovery action. Several of us felt that it really should've been covered in Chapter 15 because there was an identified deteriorating state going on. And after the last meeting and during the meeting, I had asked, what's the specific regulation for guidance that says you're not allowed to look at recovery to the COL stage or that says you're finished at 72 hours?

Well, we've kind of turned it around because we want to be finished at 72 hours. We must be. I went looking through all the regulations and found nothing hinting at this. I went to guidance, and the only place I found anything related was in this Chapter 15.4.6. And while, yeah, it's written for injection from other sources, it's the nearest thing to guidance on this situation that had been laid out.

Nothing that I read in that section says that if you're in a continuously deteriorating state, you don't have to carry the analysis out to some end point where you're not in that kind of a state. So while the answer -- it reminds me a lot of something I ran into doing work in another country where they told me that the probability of failure in their scram system was 10 to the minus 5th of demand. And I asked for their analysis, and they said, well, there's a standard that says it has to be that. So that's what it is. We've kind of turned it back and forth here, so I'm not convinced by the answer I was given. Thanks, though, for --

MEMBER DIMITRIJEVIC: Yeah, I would like to do some -- Ryan, I want to correct you in the two facts you said. First you said the multiple errors of commission are covered in Chapter 19. That's not true. Chapter 19 specifically said that no important errors of commission were identified.

And then you said the seven days is also covered in Chapter -- I have a feeling that now a lot of things are done in Chapter 19. But they're not happening there. They're not covered there. So let's just maybe you guys think they should be there, but they're definitely not there.

Also, we're asking the write up. I have one very specific scenario which is not what we are discussing here. And this is the CVCS injection after the ECCS partial failure. So the thing is which is the question is here, are we in the stable -- you are not in the stable condition after the prolonged ECCS injection.

And then therefore the Chapter 15, I think the objective of Chapter 15 is to leave the things in the stable condition, and this is not the case there. So this is why this recovery action should be discussed. That's my comment. I just want to correct about this, what's in Chapter 19 and what is not.

MR. NOLAN: Sure. Yeah, thank you for that clarification. When I was referring to Chapter 19, I was referring to the staff safety evaluation and the conclusions that are included in that SE. And I think the place you will see the seven-day finding is in Section 19.3, specific to the review of whether or not -- it has to do with the regulatory treatment of nonsafety systems review directly associated with the Commission policy for seven-day coping. And so the 19.3 does include a conclusion on seven days.

MEMBER DIMITRIJEVIC: Okay. Well, usually, when we say Chapter 19, we don't apply it to even the regulatory treatment of non-safety systems in Chapter 19. Chapter 19 usually refers to the PRA. So that's why I give a correction.

MR. NOLAN: Yeah, the SRP for RTNSS is Section 19.3, and that's where the applicant put that information into the application. And so that's why it shows up in Chapter 19.

MEMBER MARCH-LEUBA: Hey, this is Jose. Since I'm the troublemaker, I would like to throw my full support on what Dennis said. And he said it much more eloquently than I could. So I just wanted to say that I support what he said.

MEMBER KIRCHNER: Dennis, may we move on? I obviously will be --

MEMBER BLEY: Yeah, I'm done, Walt.

MEMBER KIRCHNER: -- coming back to this. Yeah, we'll come back and obviously --

MEMBER BLEY: I think there's better ways to deal with this separately. So I think we'll come back to it in letter writing.

MEMBER KIRCHNER: Yes, yes. That's my sense too.

MR. CORRADINI: So Walt, this is Corradini. Can I just ask the presenter one question? He said the EOPs can be -- or procedures can be used to mitigate the situation. But I'm a little bit confused. In this case, wouldn't I expect with some sort of actuation that the operators are aware that a dilution event is progressing that they would step in and do something? Can you explain this? Maybe I misunderstood your explanation.

MR. NOLAN: Yeah, I didn't want to overly speculate how the procedures would be written. I was just trying to make the point that we would expect the operators to follow their procedures, even if they go beyond sort of the minimum licensing basis of the facility. That's the only point I was trying to make.

There may be certain situations depending on what the event is we wouldn't want the operator to take an action. If you do have an ATWS LOCA event, it may not be a good idea to unisolate containment to prevent a dilution event. I just didn't want to speculate all the different scenarios and how the procedures may be written in the future.

MR. CORRADINI: But let me then restate it differently just so I'm on the same page with what you're saying. Your point is that a Chapter 15 event is not identified that's a boron dilution event. Am I understanding this correctly, because of the fact that they isolate --

MR. NOLAN: It's not --

MR. CORRADINI: -- the de-mineralized water system ahead of time? Am I understanding this correctly?

MR. NOLAN: Right. Yeah, so 15.4.6 addresses unplanned boron dilution events as the initiator. Uneven boron distribution, I wouldn't necessarily consider it an unplanned boron dilution event. That's just the natural progression of the transient and the natural thermohydraulic response of these passive cooling systems for this design. And so I sort of see them as one's an initiating event, one is not.

MR. CORRADINI: Okay. But then let me ask the question another way. But we're all in agreement that upon actuation of the ECCS, there will be a situation where parts of the system will be a different at boron concentrations than other parts of the system and this will progress. But that's not considered an initiating event. Therefore, the staff does not look at it within a Chapter 15 context. Am I understanding this correctly?

MR. NOLAN: No, no, no. We certainly address this as part of 15.0. And within 15.0, uneven boron distribution is addressed. And our conclusion is that if the operator doesn't take any action which is what the assumption is for Chapter 15, there is sufficient shutdown margin in the core.

MR. CORRADINI: In the core? Okay.

MR. NOLAN: Yes.

MR. CORRADINI: All right. Okay. But I think it didn't say it as precisely as you did. But what you're then saying is that recovery is -- it kind of goes back to Dennis' basic point which is, why is recovery off the table to be considered here? And your answer is because it's carried out after the event and we're in a safe -- supposedly safe situation post-event.

MR. NOLAN: Right. Our conclusion is this condition with no operator action is a safe, stable condition.

MEMBER BALLINGER: This is Ron Ballinger. It's a little bit concerning. I mean, I understand the rule, and I've read that part of it. But if you know that, well, okay, for 72 hours or seven days or whatever it is, everything is stable. But if you know that 72.1 hours later or two days, 0.1 day later the operator action could be a really bad hair day. If you know that ahead of time, does that, in some ways, defeat the sort of warm feeling that you get because everything is fine for 72 hours or seven days?

MR. NOLAN: So I think --

MEMBER BALLINGER: I mean, are we in a situation here where -- this has got to be one of the lessons learned, of course. But are we in a situation where we're ignoring something because the rule says in effect we do ignore it?

MR. NOLAN: No, I think the staff is in agreement that there needs to be a safe means of recovering the module. And this is something that I believe Dr. Yarsky's white paper addresses is, how do you use some of these systems to recover the module and what are the potential impacts on safety? And so the staff did addresses the use of those systems for recovery. My point is it's just -- it's not within the scope of Chapter 15.

MEMBER MARCH-LEUBA: Ryan, this is Jose. I don't want to ambush you. And later or when they allow me to do my comments, I wrote a white paper and sent it up the chain that was supposed to make it to you and apparently has not. I will give you this later, but I believe that Dr. Yarsky's paper is off by a factor of 5 in calculations. Whenever I'm allowed, I will let you know why.

MR. NOLAN: Sure. Well, at the conclusion of these questions for me, I believe I will be turning it over to Dr. Yarsky. So that may be a good time to bring it up.

MEMBER KIRCHNER: Yeah, let's put a pin in that matter. Let's continue with the questions that were first entered, Jose, and then we will provide ample time for your concerns.

MEMBER PETTI: Well, can I ask a question?

MEMBER KIRCHNER: Go ahead, Dave.

MEMBER PETTI: I'm just still a little unclear. I understand Dr. Yarsky's paper and he's really looking at events LOCA plus ATWS. But inadvertent actuation of the ECCS is in AOO, and you will deborate.

And basically, the staff has concluded that out to, as Ron said, 72 hours or seven days, it's okay, but it doesn't do anything. But afterwards if the operator does something, it could be really bad, although you concluded that it won't be bad based on sort of a BD/BDA scenario, not sort of a Chapter 15 scenario. Is that correct?

MR. NOLAN: So I think -- because this is just a design certification, we don't have the final system design to do a full evaluation, nor the procedures to understand how these systems will be used. However, at this stage, conceptually, we believe that the use of these systems can be -- they can be safely used to recover the module from this uneven boron distribution scenario.

MEMBER PETTI: At any time?

MR. NOLAN: Yes.

VICE CHAIR REMPE: Walt, can I ask --

MEMBER KIRCHNER: Yes, go ahead, Joy.

VICE CHAIR REMPE: I don't know if it's

redundant, but I have a question.

MEMBER KIRCHNER: Go ahead.

VICE CHAIR REMPE: Ryan, when you made these conclusions and when I look through Peter's paper in the last week or so, it seems like the operators are going to rely on water level measurements within the RPV to take such actions. And I know the actions are coming later. But when you think about those water level measurements in the vessel could be off a couple of feet, plus or minus feet, I mean, have you really thought about does the operator have good information to make the judgments required?

And I know it's a fuzzy line because they don't have to do the procedures yet. But we said you don't have to have as much rigor on and refined accuracy with the water level in the core because we didn't think the operators had to do anything. And now we're back to, oh, the operators are going to need to do something. Have you guys started to think about that?

MR. NOLAN: So that's a really good question, and that was one of the submitted questions to the staff ahead of time. And we do plan on addressing that. We plan on addressing it last. We could probably answer now or we can wait until later.

VICE CHAIR REMPE: I can wait. Just when I keep hearing, oh, the operators will take care of it, I'm just going, with what? And so yeah, I'm very interested in the answer to that question.

MR. NOLAN: So we planned on answering this question a little later. Maybe you can hold off till then.

VICE CHAIR REMPE: You bet.

MEMBER KIRCHNER: But Ryan, the distinction I think that David Petti was trying to make was he was -- we're talking about AOOs and design basis events, including design basis accidents, all of which are Chapter 15. We're not even considering yet -- the Committee really wasn't considering LOCA plus ATWS. Our concerns were just LOCA plus ECCS actuation.

Let me ask you. I think I can say, but the Committee members may correct me. I think in general based on the presentations two weeks ago, we would concur -- that's to be determined by Committee -- that the holes that were put in the riser seemed to ensure a continuing natural circulation and boron redistribution, so to speak, for the decay heat removal system passive cooldown events out to 72 hours.

And it appeared there that the figure of merit that was used was the boron concentration, and this is an average number because of the stylized analyses that were simplified analyses that were used. That the average concentration remained above the critical boron concentration with some margin. And beginning cycle, I'm doing this from memory, perhaps almost 200 parts per million equivalent boron, middle of cycle, on the order of 100.

So that provided reasonable confidence that the downcomer hasn't diluted. But it seems like now for the other end of the -- the other part of the story which is post-ECCS that you're not using that figure of merit. You're just -- if you will, you're using a figure of merit. What's the boron concentration in the core?

And I think we all would agree that the boron concentration in the core is probably going to be at the level at beginning of event, if not increased through the course of the event. But again going back to Member Ballinger's comment, it appears that if you continue to dilute that downcomer, then you put yourself in a position where any upset of the status quo could result in a slug of deborated or less borated water going into the core, displacing that relatively high concentration of boron that's in the core, and then leading to the potential for recriticality, return to power, et cetera. So what figures of merit are you using in your assessment to say, this is okay out to 72 hours?

MR. NOLAN: So the reason for the DHRS cooldown and why we were concerned with the boron concentration of the downcomer in relation to the critical boron concentration is because ECCS will eventually actuate. However, once ECCS actuates and you do get this uneven distribution with the concentrating boron in the core and diluted water containment in the downcomer, there was no mechanism in which we saw that would cause a large slug of diluted water to enter the core. What we conclude is that any water entering the downcomer is equal to the boil off rate out the top of the riser. And in that condition, our conclusion is that's a safe, stable condition.

MEMBER KIRCHNER: Okay. I just wanted you to clarify your position. I suspect that there are members that don't think that's a safe, stable condition. And --

MEMBER BLEY: This is Dennis again.

MEMBER MARCH-LEUBA: We're suspicious of it.

(Simultaneous speaking.)

MEMBER BLEY: Dennis Bley again. When you went through your original answer, you cited the SECY. And I wrote down 93-128. Did I get that wrong?

MR. NOLAN: No, that's correct.

MEMBER BLEY: I can no longer find that on the public website, and I'm having trouble finding it in ADAMS.

MR. NOLAN: I would just --

MEMBER BLEY: I would like to get that to look at, please.

MR. NOLAN: Yeah, I usually just google it, and it'll be, like, the first or second link.

MEMBER BLEY: Yeah, I did, and it isn't there. Okay. Mike Snodderly, please get 93-128 for us, if you're there.

MR. SNODDERLY: Yeah, if I could have some help from the staff on that one. I'm like Ryan. I googled it. And for some reason, I'm able to find it. But yeah, that's how I normally access it.

MR. NOLAN: So here, I may have misspoke. It's 96-128. Sorry for that. I was just going off of memory.

MEMBER BLEY: Thanks.

MR. NOLAN: Yeah, and then there's an associated SRM with that too. All I was trying to --

MEMBER BLEY: Okay.

MR. NOLAN: What I was trying to highlight with that is other designs, we did a RTNSS review and we did take a close look at the use of nonsafety systems to continue core cooling functions. And I was trying to just make the point that we did not do that for NuScale because they've demonstrated that they can get to seven days with just the use of the automatic safety-related systems.

MEMBER MARCH-LEUBA: Yeah, this is Jose. Just so we understand, I think our concerns and then my concern is if you are in a continuously degrading condition, eventually, you're going to have to recover from it. And eventually, you're going to have to transfer the module to Mode 4 which is the one that allows you to transport it to the refueling station to fix it if something went wrong, right? And that is something that will be addressed.

How specifically step one, two, three, four, five is done will be addressed by the COL? I just don't see a credible mechanism with some definitive, scientific backup that says you can do that. You base your statement that there is no credible mechanism to insert those 15 to 20 cubic meters of deborated water that's sitting in front of the core, and you're basing it on Dr. Yarsky's paper.

I'm sure. I mean, we received it one afternoon before our final meeting. And I had time to review it now, and I see some issues with it. So I just don't think that this is scientific and thorough, just to believe that nothing will happen. It's not good to me -- not good for me.

I don't want the procedure. I want you to tell me if I turn this valve and I start putting flow through this, I will recover safely. And the only argument I get and I agree with Dr. Yarsky is that we're mixing in the upper plenum. But Jesus, I need better calculation that somebody has calculated. And we'll go into details later on when it's my turn.

MEMBER KIRCHNER: Thanks, Jose. Ryan, let's continue on with the questions at this point so we can go through those first, and then we'll turn to members.

MR. NOLAN: Yeah, I think I'm going to turn it over, I believe, to Dr. Yarsky --

(Simultaneous speaking.)

MEMBER KIRCHNER: Okay.

MR. NOLAN: -- to then go through the rest of these questions or to start going through the rest of the questions.

MEMBER KIRCHNER: Okay, good. Peter, you're on.

MR. YARSKY: Hello. This is Dr. Peter Yarsky from the research staff. And I wanted to take the time to respond to General Questions A, B, and D from the questions that we received. The first question, Question A, was focused on what seems to be the main point of contention and is related to reactivity insertion rate.

And so research developed a written technical evaluation report to respond to these questions. I'm not sure if there was the opportunity for that to be provided to the Committee in advance. But I wanted to give at least a high level overview of the --

MR. SNODDERLY: Peter, this is Mike Snodderly. If I could just interrupt you for a second because I think that's a very important point. I just want to make sure we're all on the same page. So there is what I'm going to call the Peter Yarsky Report 1 which was in response to the NRR Request 0-14 and that is ML20191A069, dated July 1st, 2020. And that is --

MEMBER MARCH-LEUBA: Can you read us --

MR. SNODDERLY: -- publicly available --

MEMBER MARCH-LEUBA: Can you read us a title? Do I have it?

MR. SNODDERLY: Yes, yes. That's --

(Simultaneous speaking.)

MR. SNODDERLY: -- the one that everyone has. And I'm also trying to benefit for the people from the public to understand what we're talking about now. And so that is the first Yarsky report dated July 1st. That's the one we've all looked at during the June 3rd and 4th meeting, and it is publicly available. We can --

MEMBER MARCH-LEUBA: Is this the one that we referenced as the white paper and is --

MR. SNODDERLY: Yes.

MEMBER MARCH-LEUBA: -- marked proprietary ECI?

MR. SNODDERLY: Yes, and there is now a publicly available version, and I just read that ML number. And that's the publicly available one, and that's one that we can reference as part of our deliberations here.

MEMBER MARCH-LEUBA: So the proprietary

ECI markings have been removed from the one I have.

MR. SNODDERLY: No, no, no, no. There's a proprietary ECI version that you have, and you need to continue to treat that. I'm just saying there's another redacted version that I didn't give you because you're not as interested in the public version. But the public is, and that's the number I just read.

MEMBER MARCH-LEUBA: It would be --

MR. SNODDERLY: And that's what we were referencing --

MEMBER MARCH-LEUBA: I would be nice to have had it because I know what I can talk about and what I cannot talk about. But okay, go ahead.

MR. SNODDERLY: Okay. So that's the document that we can reference in your boron distribution letter that we're going to talk about later this afternoon. Now Dr. Yarsky has written a second paper in response to a second request from the staff, 0-15, that is proprietary and it has not been reviewed by NuScale. So there is not a publicly redacted document yet.

And so I don't know if there'll be one in time so that the Committee can refer to this. Right now, I don't think we can plan for that unless we get some kind of commitment from NuScale and the staff that it will be. Otherwise, you were in the same predicament as the Chapter 1 FSAR which we have a solution path now for as a result of the commitment by the staff.

MEMBER MARCH-LEUBA: Mike, do I have that document?

MEMBER KIRCHNER: Does the entire Committee have that document?

MR. SNODDERLY: No, no.

MEMBER KIRCHNER: Does anyone have it?

(Simultaneous speaking.)

MEMBER KIRCHNER: I know a document of viewgraphs, but --

MR. SNODDERLY: Right, that's what we have and we could go into closed session to talk about. What I'm trying -- what I would like the Committee to make sure they understand is if they do want to refer to this other paper, there are some logistical problems as far as timing. So do you really want to see this additional information, or do you just want to discuss it in public session with Dr. Yarsky and then it's on the record? But if we go --

MEMBER MARCH-LEUBA: Last time I checked --

MR. SNODDERLY: -- to the first --

MEMBER MARCH-LEUBA: Last time I checked, ACRS has access to all proprietary ECI information. We may not be able to reference it in an open letter, but we should have access to the information.

MR. SNODDERLY: Well, so it is now available, and I shared the viewgraphs with you Walt --

MEMBER MARCH-LEUBA: I see the viewgraphs.

MR. SNODDERLY: -- yesterday to determine whether you want to pursue further this document. I caution you because I don't think it's going to be part of the record so that you can reference this for this letter that you plan to write in the next day or two.

MEMBER MARCH-LEUBA: So --

MR. SNODDERLY: That's all I'm saying.

MEMBER MARCH-LEUBA: -- let me see if I understand correctly. The staff is asking us to write a letter on an SDA we have never seen and make judgments on the quality of the technical content of a document that was created yesterday and we have never seen.

(Simultaneous speaking.)

MR. SNODDERLY: I would say it a little

different, Jose. The staff has additional information that the Committee may consider. But right now, it is still proprietary and it has not undergone proprietary view yet by NuScale.

MEMBER MARCH-LEUBA: I think --

MR. SNODDERLY: They can tell us where that is in process.

MEMBER MARCH-LEUBA: I think I placed my concerns on the record that this is not proper procedure.

MR. SNODDERLY: It's --

VICE CHAIR REMPE: Mike --

MR. SNODDERLY: -- late in the process.

MEMBER PETTI: Mike, this is Dave.

VICE CHAIR REMPE: Please share --

MEMBER PETTI: I just can't --

VICE CHAIR REMPE: -- the graphs in the document with all of us.

MEMBER PETTI: Yeah, I just can't -- given the magnitude of what this letter is about, we need all information, proprietary, not proprietary. We're talking about probably the most important letter we have to write on NuScale, and I feel like I've got it tied behind my back now because you told me there's some new information that we're hearing only today.

So I recommend --

(Simultaneous speaking.)

MEMBER RICCARDELLA: Can't we go into closed session and review the -- and go through those viewgraphs?

MEMBER KIRCHNER: I think that's what we need to do, Pete.

MEMBER MARCH-LEUBA: Pete, I would strongly recommend against it because I still have some items that have been placed on the open record.

(Simultaneous speaking.)

MEMBER KIRCHNER: No, no. We will let you do that, Jose. We're not proposing to, in any way, prevent you from putting something on the record. What I'm just agreeing with Pete is -- and Mike Snodderly, I think what we would want is an ask of the staff for Peter Yarsky to go through. The viewgraphs that were provided late last night, I believe, are a summary of what you're identifying as the second white paper. Do you I understand this correctly?

MR. SNODDERLY: That's correct, sir. That is correct, sir.

MEMBER KIRCHNER: So let us ask for the staff, Peter Yarsky, to present those viewgraphs in a closed session. I think we have to do that at this juncture. But let's --

MR. SNODDERLY: I would suggest --

MEMBER KIRCHNER: -- finish the questions.

MR. SNODDERLY: -- before you do that, for the benefit of the public, though, I think it would be helpful for Dr. Yarsky in public session to provide some description --

MEMBER KIRCHNER: Yes, a summary description of the report.

MR. SNODDERLY: -- what he did, why he did it, and what confidence it gives him now in his previous conclusions in papers because my understanding is the staff asked for this support because they wanted more certainty. And so if he feels that this gave him more certainty, he should be able to describe in general terms what he did and why it gives him more certainty. And then we can go into closed session for a more detailed discussion.

(Simultaneous speaking.)

MEMBER KIRCHNER: We can ask him to do that. Let's finish. Dr. Yarsky had started on the questions. Let's do that. I think we're agreed now on further steps and what we would do in closed session, and we can ask Dr. Yarsky to just summarize for the public what these two papers contain.

VICE CHAIR REMPE: Walt, while we're going through the rest of the open session, may we request that Mike Snodderly provide that information to us and in an appropriate location on the SharePoint site and send us an email and let us know where that information is, the white paper and phase two of the paper and the viewgraphs now.

MR. SNODDERLY: I do not have --

MEMBER KIRCHNER: Just --

MR. SNODDERLY: I do not have the second paper. I have some slides that I asked the main members to make a recommendation of whether it should be considered further as part of the record. I do not think it will be available in time, and that's why I was suggesting that we not consider as part of your deliberations.

I do not have the paper. I have the slides that we agreed with the staff that if they decide they want to use them as backups -- right now, they're backup slides. Once they present them, then they'll be part of the record and I will share them with the Committee.

VICE CHAIR REMPE: Why can't -- if you've shared it with two members, please share the slides with all the members now, please.

MR. SNODDERLY: After the staff says that they will put those slides on the record, then yes, I will share them with all the Committee.

VICE CHAIR REMPE: This is not the normal way we do business.

MR. SNODDERLY: I ask that you appreciate the time constraint that I've been put under and then I tried to do the best I can to share this information.

MEMBER KIRCHNER: No, we appreciate that, Mike. Okay. Joy, I will ask -- I'm asking formally of the staff please provide the viewgraphs to all the members on their NRC email -- at their NRC email address, not SharePoint.

MR. SNODDERLY: Okay. So we are going to then go into closed session and put these slides --

MEMBER KIRCHNER: Yes.

MR. SNODDERLY: -- then on the record as proprietary documents. I understand --

MEMBER KIRCHNER: Yes.

MR. SNODDERLY: -- and I will do so. And I will --

(Simultaneous speaking.)

MEMBER KIRCHNER: Yeah, thank you, Michael. That's fine.

MR. SNODDERLY: Okay.

MEMBER KIRCHNER: Just so --

MR. YARSKY: And Mike, Peter Yarsky from the staff. I just wanted to clarify that of the slide package, we had marked two of the slides as proprietary. But they are not proprietary as of 2015. So that was a mistake on the part of the staff. None of the slides contain proprietary information.

MR. SNODDERLY: Oh, fantastic. Then I'd ask you to --

(Simultaneous speaking.)

MR. SNODDERLY: Then let's go to the slides, and then they're on the record and everybody has them.

MR. BAVOL: Mike, this is Bruce Bavol.

MR. SNODDERLY: Yes.

MR. BAVOL: To be clear, NuScale has not reviewed any of that information for proprietary because we got it yesterday afternoon.

MR. SNODDERLY: That's my understanding.

MR. BAVOL: Yes, so I mean --

MR. SNODDERLY: And I'm sorry if I didn't say that clearly. But yes, that was my understanding.

MR. BAVOL: That's staff's input, and I appreciate -- and it's most likely correct. Just we haven't verified it through NuScale that any of those slides do not contain proprietary information.

(Simultaneous speaking.)

MR. MOORE: So this is Scott Moore. Bruce, can you expedite your review so that if it is not proprietary, we could get it on the record as soon as possible?

MR. BAVOL: I will -- yes, I mean, this is an arrangement that we were talking about yesterday. But I'll pursue that, Scott.

MR. MOORE: Thank you. And just for all of the members, I'd remind everybody that the staff has been getting documents at, like, 10:00 o'clock at night and being asked to distribute them. So the staff is doing its best to get you all documents.

MEMBER MARCH-LEUBA: Hey, Scott. This is Jose. I recognize you are under a big constraint. I mean, you're put in a real bad position. But they're asking us to write a letter, ACRS, a distinguished body even though I belong to it, by Friday. And I just don't see how I can support that when information keeps coming up that we cannot see.

MR. MOORE: The staff will make information available the Committee as a whole requests. And once on the record, we will provide you with the information you need to make decisions by Friday.

MEMBER KIRCHNER: But I think -- yeah, without going into great detail on this, I think we can go into closed session and we can have those viewgraphs presented to us in closed session. And I think for the public record, we can make it clear, at least in a general way, what the content is while we wait for a review from NuScale and a determination as to whether they can contain proprietary information and whether they can then be posted on open. But that doesn't stop us from going into closed session and considering the viewgraphs.

MEMBER MARCH-LEUBA: Walt, can I make a suggestion?

MEMBER KIRCHNER: Yes.

MEMBER MARCH-LEUBA: I've read the slides, and you remember two weeks ago I was saying to everybody that you were misquoting Dr. Yarsky. Dr. Yarsky in those slides has a novel theory of why the front does not become a problem of reactivity insertion in the core. And it's not the same theory that is reflected on the SER.

And the paragraph that I want to point out some mistakes in the calculation. So if we could hear in the open session from Dr. Yarsky was a series of why this 15 to 20 cubic meters of deborated water in the lower plenum, downcomer, and containment coming into the core do not cause a problem. It would be -- I think his theory is not NuScale's theory. I think it would be valuable to do it in open session because these are something completely different.

MEMBER KIRCHNER: Okay.

MEMBER MARCH-LEUBA: And I know what he said.

MEMBER KIRCHNER: So with that, we interrupted Dr. Yarsky. Peter, would you like to venture and continue?

MR. YARSKY: Yes, Walt. Thank you. I would like to continue in open session because I believe that 100 percent of the information I'd like to discuss in response to these questions is appropriate for the public session.

MEMBER KIRCHNER: Good. That's to be welcomed. Thank you.

MR. YARSKY: Okay. So in response to Question A, this we're referring to as the main point of contention issue. I think it needs a little bit of clarification, and I do appreciate Jose's comment with regards to interpretation of the staff position as presented in the previous white paper. And I would like to take this opportunity to hopefully clarify some of that rationale.

First, this was something that was not done in the original white paper. But I think it is valuable to try and think about possible mechanisms of what we've referred to as flow incursion that could transport deborated water from the downcomer into the core as falling into one of two categories. The first of these categories we could consider as like a transient mechanism.

An example of a transient mechanism would be if the ECCS were to -- if the ECCS valves were to open, this would create a level swell followed by flush that in a transient short-term way would create sort of a flow pulse and that after that initiation and that short transient, the driving force that's propelling the transport of the fluid goes away. So it's like a transient mechanism. These tend to be more rapid, and there's sort of a sudden movement of fluid and then it doesn't continue.

The second type of mechanism or second category rather of mechanisms I think we would call a prolonged mechanism. And this would be something more akin to a recovery type operation where, for instance, CVCS or CFDS is put into an injection mode in order to raise water level. And in that kind of scenario, that continuous injection is providing a prolonged core flow increase that is sustained over a long period of time.

And so for these more prolonged mechanisms, the staff went about calculating the reactivity insertion rate. And I believe that this has led to some confusion. For a hypothetical manual operator action to increase level in this prolonged mechanism, that can lead to the transfer of deborated or low concentration water from the downcomer into the core. And that would progress at different rates depending on what systems are being used to provide that injection.

And we calculated for a completely deborated downcomer what that reactivity insertion rate would be. However, we do not believe that that rate is indicative of a continuous accumulation of reactivity at that rate. We wanted to calculate that rate in order to get an idea of just the timing of the dynamic process, to get an idea of what the time scale was for -- is this something that is a very rapid process, or is this a very slow process?

And the reason for that calculation was to compare that timing to what would be the mixing time in the core region. And so ultimately, I believe, the main point of contention relates to whether or not there are physical processes or phenomena that would lead to the mixing of the low concentration downcomer water that's being moved into the core region and the high boron concentration water that's in the core riser region.

And so with these prolonged mechanisms in mind, if it takes a very long time to insert a dollar's worth of reactivity according to how we calculated that rate and that amount of time is much longer than the amount of time it would take for the inventory to mix. Then we contend that the reactivity doesn't accumulate. That mixing process sort of takes the reactivity out of the deborated water by restoring high boron concentration in the core average, more homogeneous inventory in the active region.

And so I hope that that partially clarifies the staff's position about the importance of phenomena relative to the time scale. So I wanted to pause and ask if there was, like, any questions relative to that clarification because I would like to discuss more afterwards about what this -- what generates the mixing phenomena and what the evidence is that such mixing would take place.

MEMBER MARCH-LEUBA: Mr. Chairman, I think this is a perfect opening for my complaints about Pete's calculation, and I would like to go ahead and do it. Okay? Pete --

MEMBER KIRCHNER: Dr. Yarsky, are you amenable to an interruption here so that Member March-Leuba can enter into the record his concerns?

MR. YARSKY: Of course. I think I paused for such an interruption.

MEMBER KIRCHNER: Yeah, okay. Thank you, Peter. That's a good summary. I believe that that's a good summary of the state of affairs in terms of what the Committee is concerned about. So with that, I'll turn to Member March-Leuba.

MEMBER MARCH-LEUBA: Okay. So I am going to read from the open SER Section 19.1.4.6.3 called reactor building -- oops, sorry. I went up too far. 19.1.4.6.4, success criteria accident sequences and system analysis.

In this section, the staff of the SER -- the final SER, the staff quotes, a calculation, which we will attribute to Dr. Yarsky, in which he says or they say that the maximum reactivity insertion is approximately 29 dollars. And that's how we calculate this PRAM rate that you hear me say a lot two weeks ago at one dollar per minute. This 29 dollars are calculated by assuming that the boron concentration in the core is the initial BOC concentration which is 1,250 ppm.

And then the SER uses a linear approximation with a boron coefficient of 14 PCS per ppm. I'd rather use 10 because I know it's nonlinear and it's -- so parenthesis, this is an approximation. This is a linear approximation that the real numbers will differ when you do the real calculation.

But this 29 dollars are assuming the deborated water in the lower plenum displaces 1,250 ppm borated water in the core. But we know by now from RAI-8930 that the concentration in the core at this time, we're talking, say, 72 hours after the initiation of the transient. The boron concentration at this time is at least 4,000, and the staff have told us -- not staff. The applicant has told us orally that if you do it more from an estimate, it could be as high as 6,000. So it's not 1,250. It's 6,000.

If you use the same calculation the staff used for this paragraph on Chapter 19, instead of 29 dollars, I calculate the perturbation is closer to 140 to 150 dollars. And in units that Charlie Brown would understand, he doesn't like dollars, this is a delta K over K of 0.6. And I'm not talking 0.6 percent. I'm talking 60 percent, delta K over K of 0.6. This is an incredibly high perturbation.

If you are displacing 6,000 ppm borated water from the core with the front that moves in, you are not having a one dollar per minute reactivity. You're have a five dollar per minute reactivity. And reality, this assumes that the front is flat like water and oil. It's uniform and it's moving slowly. But we all know that the center of the core will have a higher flow.

So your front would be more like a parabola or maybe a sine wave with lows on the outside. But the water -- the volume -- the volumetric rate of deborated water into the core will go mostly in the center of the core. It's the one that has the high reactivity worth. And it likely not be five dollars per minute. It'll be probably six, seven, eight dollars per minute when you do the proper weighting.

So the argument that the SER makes that one dollar per minute is such a slow rate, I never believe I'd say that one dollar per minute is a slow rate. But it's slow enough that you will be at thermal equilibrium. It doesn't hold water when you actually make a back-of-the-envelope calculation with a real concentration of boron.

And you're having now five, six, seven, eight dollars per minute. And now you are close to the fuel thermal constant. So number one, the SER numbers in this section, I said it before, they're incorrect. They need to be corrected.

MEMBER KIRCHNER: Hey, I would -- Jose, since we're on the open record, I would say the following. I would say that the estimates in the SER certainly could be subject to question and interpretation. I would submit that in your scenario, one of the problems is that the rather stylized, simplistic boron concentration estimates I do not think would reflect what a best estimate calculation would provide.

And by that, what I mean is you would not have a 4,000 or a 6,000 dollar -- 6,000 ppm concentration. It would be much less because it would be spread through the lower plenum and the downcomer. If you really took mixing into account, you wouldn't have this stylized, static buildup of all the boron only in the core and the riser. That is just not physically possible.

So I would say that -- I would not say that their estimates are incorrect or in error. I would say that one could postulate as you do a static worth that bounding would be a much higher rate of reactivity insertion.

MEMBER MARCH-LEUBA: Okay. And with that --

MEMBER KIRCHNER: But --

MEMBER MARCH-LEUBA: With that rude interruption, may I beg you to let me finish?

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: And so I will not answer to your comment until after I finish. Okay. So in my opinion and given the only calculations I have on record from the applicant tell me that they have at least 4,000 ppm of boron. You cannot assume 1,250. It will not possibly be 1,250.

So let's go back. So the perturbation is going to be up to 140, 150, likely much lower when you consider nonlinearities. And the core will be very subcritical when you start. Okay. That's not important to the run rate. The run rate is at which velocity do you displace boron from the core. And you're displacing boron from the core in my estimate at five, six, seven, eight dollars per minute.

Furthermore, once you reach K effective equal one which if you have 6,000 ppm overall will be late of course. Once you reach K effective of one, you will return to power and you will start generating voids in the riser. And Dr. Yarsky's paper properly identifies the only thing that can get in trouble with ingress of water honestly is reestablishing that circulation. Any other sort of injection is very slow.

So if you regain power and the core riser void fraction becomes close to 50 percent by eyeballing some of the drawings we have in the documentation, the riser -- the two phase flow level in the riser will go over the top of the riser and will start overflowing. And that circulation will start occurring. And that circulation is a fast mechanism to inject cold unborated water. So if you -- this slow ingress ever gets you into a K effective of one and a little bit more so you have power of five, ten percent which was required for 50 percent voids, you will get a positive flow feedback that would put a lot more cold unborated water into the core and you will run out.

MEMBER KIRCHNER: Jose, may I interrupt?

MEMBER MARCH-LEUBA: No.

MEMBER KIRCHNER: Okay. Well, you are good at interrupting. I thought you would be --

MEMBER MARCH-LEUBA: Walt --

MEMBER KIRCHNER: -- a little more flexible.

MEMBER MARCH-LEUBA: Walt, Walt, Walt, please. You've never listened to me. Okay. Let me do the --

MEMBER KIRCHNER: I do listen very well to you.

MEMBER MARCH-LEUBA: No, you don't. No, you don't. Okay. So I've described two problems with what we have on the books. First, the run rate is not one dollar per minute. It has to be greater.

Second, if the SER says, well, without run rate, we'll eventually reach criticality. But we will be in thermal equilibrium with the fuel and with some feedback and we will still satisfy SAFDL. Fine. But if you can get the power high enough to get 50 percent voids, you will get a positive flow feedback that will put a lot of water into the core. This mechanism was not identified by the staff or the applicant as one possible source of borated water -- of unborated water into the core.

Number three, when I run the calculations in my head and I don't have MCMP -- I do have MCMP, but I don't have a MCMP model. I have a MCMP license. When I write in my head, the void reactivity coefficient of a highly heterogeneous core which has clean water and 6,000 ppm water is almost sure positive. So the moment you get to K effective equal one, my head calculations tell me that you won't even have to restart that circulation. You will get into a positive feedback that will run away the reactor.

So I have three different arguments why this is not a safe solution. And I'm not saying that when we run MCMP and TRACE or a good model, you can actually prove that good things happen. It may, but I don't see anybody addressing those three different problems, and I just cannot support this. Okay, Walt. Now you can start throwing rocks at me.

MEMBER KIRCHNER: No, no, no. You wouldn't even let me agree with you on anything. So first, I guess I would observe, Jose, a few things. I actually agree with you on the concern about the reactivity rate.

I do personally believe that you will get mixing. This idea of just a uniform front slowly progressing into the core defies -- well, you'll get mixing in a system like this. It's something that should be analyzed. I think it works to mitigate the ramp rate and such.

Second, I am with you. I am concerned if you return to power and you start generating any kind of void, there's the distinct possibility of just having a geyser-like effect. Now depending on the amount of void as you point out, one of the things Dr. Yarsky pointed out in his first white paper which was one my biggest takeaways at a technical level is for the public, we talk about when you have high concentrations of boron, essentially this creates -- it's like having a black absorber of neutrons.

So at these very, very high concentrations which I don't think will actually occur in the actual system because of mixing throughout the system, essentially the upper part of the core as it's displaced, if it's displaced slowly, will basically remain black until, as Jose points out, if you did return to critical and you started generating voids, then you have a concern because you could push up on the riser. If you have enough void, it could spill over. I don't think the spillover, Jose, reestablished natural circulation.

The level in the downcomer is too far down to have an actual natural circulation reestablished. You need to have both levels at the riser level to have a full reestablishment of natural circulation. But I do agree with you that if you have a swell that that could lead to a power excursion. And that could -- the void formation could spill over, and that would drive more water from the downcomer lower plenum into the core.

So one then -- because it's now at a low pressure, because we're post-ECCS in the scenarios that we're very concerned about, there is the possibility of the system going through an oscillatory mode. This is why we don't operate BWRs at low pressure, for example, because of the void feedback effects. And I agree with you. If the voids get high enough in that very black core section, then you have an amplification potential.

But I would remind everyone that we're using -- because we're doing heuristic arguments in our head, we're using static worths. And this is a dynamic problem. And the kinetic feedback effects, the first order, it's an undermoderated core.

If you did have that front come in, the general feedback, as long as the upper part of the core remains in a black configuration is going to be

-- how should I say it? It will be in a negative direction. In other words, it will kind of self-regulate the power excursion. But still there's the possibility then that you have manometer oscillations as a result of the first incursion.

So the bottom line for me remains one of preventing that lower plenum and downcomer boron concentration from falling below the critical boron concentration. And it's not apparent to me, and I would ask Dr. Yarsky if he's looked at this. I think he has a viewgraph that looks at different time scenarios.

But it's not apparent to me that that critical boron concentration doesn't fall -- I'm sorry, that the downcomer concentration doesn't fall below the critical boron concentration, I think in a time that's measured in maybe just a couple or a few hours, not 72 hours for some of the small break LOCA transients that were examined. So Jose, I'm trying to agree with you.

MEMBER MARCH-LEUBA: Okay. Thank you for agreeing, but let me summarize what I said. The SER -- the staff SER has a blanket statement that says, we have evaluated thoroughly all possible mechanisms for what Dr. Yarsky called a slow water ingression by operator action into the core. And none of them can cause severe core damage.

I have three arguments that need to be addressed before that statement can be substantiated. Number one, the ramp is now one dollar per minute, but it's maybe five, six, seven, eight. Number two, the void coefficient -- void reactivity coefficient may be positive. I haven't seen a calculation that it's not.

And number three, if you return to power and you start spilling over the top of the riser, you accelerate the rate of ingression of the cold water. So there are three mechanisms I can think of that have not been addressed to confirm the statement on the SER. Walt, would you allow me another two minutes?

MEMBER KIRCHNER: Yes, go ahead.

MR. YARSKY: Jose, would the staff have an opportunity to respond to those three items?

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: Yes --

(Simultaneous speaking.)

MEMBER KIRCHNER: Yes, of course Dr. Yarsky.

MEMBER MARCH-LEUBA: Let me -- let me finish with one thought. I agree with -- with Dr. Yarsky that this is not likely to happen because he thinks mixing will occur. Let me put it in pre-kindergarten level, okay? So that the people that -- the members of the public that can -- reading this transcript can understand it. What Dr. Yarsky is saying is that water from the longer plenum, which is deborated, we move through the core with criticality. We go through the upper plenum, mixed with all the boron -- there are lots -- amount of boron that have accumulated in the -- in the riser -- and then come down and get into the core with a proper boron concentration so it will not cause a criticality.

So when Dr. Yarsky says mixing, what he means is the lower plenum and downcomer mixes with the riser without causing a criticality as it goes to the core. Yes, Dr. --

(Simultaneous speaking.)

MEMBER KIRCHNER: Jose, we should let Dr. Yarsky give his scenario. But before then, I -- when I was talking about mixing, I am not talking the riser. I am talking about mixing in the lower plenum to begin with -- and the downcomer. It's incredible to postulate that there's no boron in the lower plenum or the lower downcomer. Secondly, it's only a result of a stylized set of assumptions and analysis with only three nodes, if I remember correctly. Secondly, the mixing I am more concerned about -- I -- even if the core and the upper riser are thoroughly mixed -- which they probably are because of the thermal conditions and delta Ts in -- in that part of the system -- it's immaterial. It's essentially a black core, whether it's 2,000 -- 4,000 or 6,000 PPM.

The mixing I am talking about is the mixing as you come through the lower core support plate and into the core. And that's the critical issue in my mind because that's -- that's where you're going to prevent the initial criticality.

MEMBER MARCH-LEUBA: The initial one, yes. But you have to remember that you have 15 to 20 cubic meters of deborated water. When I say deborated water, it's like --

(Simultaneous speaking.)

MEMBER KIRCHNER: But you have to -- you have to postulate a mechanism, as Dr. Yarsky points out, to rapidly insert that amount of water. And you -- we haven't been able to do that. I can think of some scenarios that will give a -- a nudge to the system, like injecting CVCS, cold water in the upper riser. That will certainly induce a flow. But when you say that this 15 core volumes are -- are there, there's no plausible mechanism, particularly coming out of the containment, to get that water into the core in a rapid manner as Dr. Yarsky divided the -- the problem.

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: It doesn't -- it doesn't need to be rapid -- as we know, it takes roughly a minute for -- for a whole core volume to be replaced with the other water. But if it mixes, it comes in, you will get more deborated water that follows. You have 15- to 20-cubic meters of deborated water. And when I said deborated, I mean 100 PPM, or low-borated -- because there will always some volatility and some concentration. But certainly not above the CVC.

So if you mix the first round that comes in with the core, you will change the core -- and the core concentration now will be half of what it used to be. As the next one comes on -- because there is 14 of them -- you will go half again. You will be 25 percent. And then it will 12.5 percent, and then six percent -- and eventually you'd want to go critical. It leaves so much water following the train --

(Simultaneous speaking.)

MEMBER KIRCHNER: Yes, but you have to mechanism to get it into the core. I think that's --

that --

(Simultaneous speaking.)

MEMBER KIRCHNER: -- that's another simplistic assumption, Jose, that -- that -- you know, sometimes I would -- I would point out that when we make these kind of bounding analyses, we actually aren't necessarily getting a conservative result.

(Simultaneous speaking.)

PARTICIPANT: -- can you entertain somebody else --

PARTICIPANT: Yes, yes. Yes, yes -- I heard both Dennis and I think I heard David Petty. Go ahead, Dennis.

MEMBER BLEY: Okay, I -- I would just like to say a couple of things because I am not sure we're making progress here. I -- I -- three or four things. I'll start with what Peter told us earlier. I really appreciate your physical description when -- that's an interesting approach and I want to hear more.

Secondly, for me thinking about this, this is really complicated. Walt said it's dynamic. It's also stochastic. Before all this starts to happen, if we don't have a BWR with channels -- we have an open area -- we're going to have some natural circulation going on inside the core region in other areas. And it's stochastic. And we're hearing a lot of stuff on the fly. It doesn't seem to me we're ever -- we're at this point, when we're trying to write a letter, are going to resolve these things. And I think the draft letter I've seen has pointed out ways to deal with this so that we can move some of this out into the future. So I -- I think that's a better approach, but I do want to hear everything more that Peter has to say.

MEMBER KIRCHNER: So I -- yes. Let's go back to Dr. Yarsky because I think that was a -- we -- we broke into the middle of what he had started to allow member input. So Dr. Yarsky, back to you.

MR. YARSKY: Thank you, Walt. I would like to take an opportunity to respond to some of the questions and comments raised by the committee members before continuing on the planned content of the presentation with regards to --

(Simultaneous speaking.)

MEMBER KIRCHNER: Yes, go ahead -- go ahead, Peter.

MR. YARSKY: First, Walt, to your comment, I would like to address this concept of the boron concentration remaining above the critical boron concentration. And I think there's a -- perhaps maybe a bit of confusion with regards to the event progression for LOCA versus extended DHRS cool down. In the LOCA progression, because the level drops below the riser holes, there -- the downcomer will become diluted, and the concentration of boron in the downcomer will drop below the critical boron concentration. I think that -- so just to clarify on that point that the -- when the staff considers these flow intrusion phenomena, we are considering them of course for a --

(Simultaneous speaking.)

MEMBER KIRCHNER: I agree with you, Peter, it will. That was my concern.

MR. YARSKY: Right. And it will drop below that concentration. And I don't think there's any -- I think Jose is correctly characterizing this, is that you'll get to some low concentration. It's just however long you let it go, the concentration will just keep getting lower. As to Jose's comment about the reactivity insertion rate, I stand by the -- the reactivity insertion rate that's calculated in the white paper. And I think it may be worth trying to spend a couple minutes to clarify that calculation and what's -- what's being assumed and why it's being done that way. But of course, like I will admit, it would be much easier if there was a white board and we could have a conversation and -- and sort of put up equation and such. So we may -- we may reach an impasse over the phone, but I would like to -- to try and discuss that.

When we calculate this reactivity insertion rate, we -- step one is to conceptualize a core that all of the fluid -- all of the coolant is this deborated coolant and to calculate what the K effective would be for that scenario. And so that's the -- why we're using the boron coefficients that are reported in Chapter 4 relative to a nominal condition.

So it's -- it's not based on the assumption that the -- the front -- and I really hesitate to use language like this because I don't think it's physical. That the -- the front would be impinging on an already critical -- or a condition where the boron concentration is not the critical boron concentration. It's rather, we wanted to calculate the K effective of the core if the boron was removed. And then to postulate if you have a level increase, giving it a rate from the potential change in the core flow, that will translate to a height of that front penetration into the core. And it's with that conceptual picture that we are calculating the reactivity insertion rate.

But it is agnostic as to the initial reactivity of the core. So if you think of like reactivity insertion, it's like Delta K by K, and then just thinking of like how Jose has posed it, of course if the initial boron concentration is 6,000 PPM, the K effective at the onset is very low. So Delta K by K will be tremendously bigger. So while I think the -- like I stand behind the staff's calculation, I think there's just a misunderstanding of how we're using the terms to compute what that is, and it's just a difference in the conceptual picture behind how we did that approximation.

But I will say that while the -- if you calculate the reactivity insertion rate using Delta K by K, and you have an initially very low K effective -- that that will amplify the delta K by K. You really don't care if you're adding a dollar of reactivity to a core that's subcritical by 20 dollars. It's not safety -- it's not safety significant at all.

And I think this feeds into the next concern of that if you have a core at an exceptionally high boron concentration -- say 6,000 PPM -- at that concentration, surely the moderator void coefficient is positive. But the core is so deeply subcritical that the introduction of void -- ultimately, the most void reactivity you could ever insert is to completely void the entire core, and that condition will also be surely subcritical. So having a positive void coefficient under a condition where you're only going from a subcritical condition to another subcritical condition doesn't pose a threat to the safety limits.

(Pause.)

MEMBER MARCH-LEUBA: Are you done, Pete?

MR. YARSKY: I think, with addressing those points. I would like to move on to the discussion of mixing, and then -- and --

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: I would like to argue with you a little bit and I would like --

MR. YARSKY: Okay.

MEMBER MARCH-LEUBA: -- and I would like to -- I agree with you that the core will be -- if you have a 6,000 PPM boron concentration in the core, it will be highly subcritical. So then this number, I was pointing it out, of 140 is only to calculate the ramp rate. The real reactivity above K effective of one, you should have used the critical boron concentration divided by the boron coefficient, and that will give you -- your maximum K effective would be 1.02. Okay? That will be calculated with the critical boron concentration, not with the initial boron concentration before the accident happened.

But the ramp rate is how fast are you displacing grams of boron from the core? Okay? So even though your final K effective will only be 1.02, the ramp rate will be 5 dollars per minute because you're displacing a lot of grams of boron per minute, because there are a lot of grams of boron. So it will take maybe an hour -- because we're injecting water very slowly -- but eventually we will have displaced 80 percent of the core, and we will reach K effective of one. At that point, you will continue to have a five-dollar-per-minute ramp rate.

(Simultaneous speaking.)

MR. YARSKY: But Jose, the -- the continuation of this rate -- well and I -- of course, I hesitate to talk about it in these terms because I don't think it physically occurs in this way, but you -- that calculation of the rate depends on the initial average boron concentration in the core being very high. By the time you get to the condition where the reactor is critical -- and now there's a potential safety concern -- the K effective of the core is one. So that reactivity ramp rate gets back to the staff's number.

MEMBER MARCH-LEUBA: No, it depends on how --

(Simultaneous speaking.)

MR. YARSKY: The reactivity ramp rate isn't continuous in that perspective because it depends on how much boron is currently in the core, and that ramp rate will decrease as the core is approaching criticality.

MEMBER MARCH-LEUBA: Why would it decrease? I mean the -- the boron concentration is -- on the top of the core is 6,000. You are still injecting so many grams per minute of the same grade of the beginning.

(Pause.)

(Simultaneous speaking.)

MR. YARSKY: Well, I'm not -- one, yes, we will get to talking about --

MEMBER MARCH-LEUBA: Mixing is -- mixing is what saves you. But let me put a final concept, and then I'll shut up. The last time I checked, Jose's gut feeling and head calculations are not an approved method to verify the safety of any reactor. Neither is this, okay? I have been saying it over and over and over that I am not saying that this is going to happen to the reactor. I am saying that it could, and I don't see a calculation that proves it wrong. And I cannot justify, yes, with waving my hands that this is going away because it could be bad. Over and out.

MEMBER KIRCHNER: Okay. Dr. Yarsky, back to you please.

MR. YARSKY: Okay, so I think the next topic I would like to discuss is the mixing. And what I believe will occur, even before any kind of boron redistribution, but you know once the natural circulation flow loop is broken between the riser and the downcomer, that an internal recirculation flow pattern will develop within the region that's bounded by the riser wall. So this will include the core and the riser region. So there will be a portion of flow that's rising, and a portion flow that's in downward flow, creating an internal recirculation flow loop in that region.

That flow loop will contribute to the homogenization of the liquid phase within that region. And what the staff has done in response to this question was to perform a literature review of experimental evidence that demonstrates the phenomenon that lead to these internal recirculation flow patterns, particularly under pool-boiling conditions and two-phase conditions.

And so we've looked at a variety of experiments -- both heated and adiabatic -- they show this natural internal recirculation flow loop developing. And have looked at that both in separate effects past as well as integral effects tests. And ultimately, also looked at experimental conditions at the PKL facility for a test that was conducted specifically to look at high boron concentrations from the standpoint of boric acid precipitation, which we believe develops similar from hydraulic conditions to what would be expected for the NuScale plan under ECCS cooling. And you know, that experiment demonstrates that these internal recirculation patterns homogenized the boron concentration -- even below the core, through the core and above the core -- and in the periphery of the core.

And so we think that there's a strong experimental basis for believing in the internal recirculation flow pattern, and that such a flow pattern would mix boron inside the core and riser region. This flow pattern develops and is enhanced by the formation of voids, which become channel leading to like an internal core of the flow that is at a slightly higher void fraction and higher upward velocity, and a periphery of the flow, which is in the reverse direction.

And because that's the nature of the flow pattern, we believe that mixing will also take place inside the core, which is -- while we've had many discussions about the -- the ramifications that a propagating front through the core may have on reactivity, I have been hesitant to have those conversations because I don't think that's a physically accurate picture. I believe that we have strong evidence that there would be this internal mixing -- this internal recirculation which would lead to mixing, which would disrupt any kind of front propagation through the core.

MEMBER KIRCHNER: Can -- Peter, this is Walt Kirchner. I would just concur with you, and if the -- if the concentration of boron is high, it -- the details then are immaterial. You will have pretty much a homogeneous core in terms of boron, especially if it's a higher concentration. As you pointed out in your first white paper, effectively that core is then black neutronically as -- as an event progresses.

But you've mentioned something -- yes, there's a lot of experimental evidence to back up what you said, and I think when we get to the -- the view graphs, the staff, the members of the committee will see that. What about the mixing from the core into the lower plenum? Have you considered that?

MR. YARSKY: So this is -- so this mixing between the core and the lower plenum is something that's predicted in the staff's TRACE calculations, but I am not as confident in that calculation. There is -- so when you're using systems tools to compute the transport of boron through the system -- for instance, in TRACE we assume that it's transported with the liquid phase.

And if you want to rely on the TRACE calculation wholly to tell you the evolution of the boron distribution -- and this is something that, in the white paper we have -- we've not done -- because there are numerical considerations that can affect the propagation of boron in such a way that you would have to -- you would have to study the numerical solution and the effect that it has on that mixing.

So for instance, in a series of TRACE calculations that we performed, there was a small level oscillation between the collapsed liquid level in the riser section and the level in the downcomer that led to a small amount of sloshing back and forth through the lower plenum. And you know, that sloshing back and forth is going to be sensitive to the time step size that you assume in the calculation. So while I think there will be some of that, I am just not confident enough that we are able to separate out how much of that prediction is coming from the numerical solution and how much of that predicted mixing is physical -- that I think it's -- would be prudent to ignore -- to ignore that -- that mechanism for mixing.

And I think that's reflected in the Applicant's analysis. And I think that you've seen a number of times when some things are sort of calculated offline and fed back into a systems analysis. And I think it's just something that's -- it's very difficult to -- without a lot more study, at least -- to have confidence in a systems analysis prediction of that kind of mixing ahead of time.

MEMBER MARCH-LEUBA: Pete, on TRACE calculations, you have what's called a vessel component, which is a 3D and does include three node --- calculation of the 3D flows in the -- in an open area like the riser. When you get into the core you have chan (phonetic) components which were -- are one-dimensional, and you have may have some leak paths between chans. So you go from 3D to 1D and that might be the main cause of why you get flow reversal in the lower plenum because --

(Simultaneous speaking.)

MR. YARSKY: Well Jose, we don't have channels in -- in this calculation.

MEMBER MARCH-LEUBA: Oh, so you have heat -- heat -- heat --

MR. YARSKY: Heat structures in the --

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: Heat structures --

MR. YARSKY: And there -- there are different models that we use for different analysis purposes.

MEMBER MARCH-LEUBA: It's a very crude -- it's a very crude calculation -- to --

(Simultaneous speaking.)

MR. YARSKY: Yes, but I think we can -- in any case -- and this will be true across like all systems codes. And you're -- you're fundamentally -- at some point you're going to have a liquid velocity in the vertical direction, and you're going to multiply it by the time step size, and that's going to translate to like an average nodal density. It's going to feed back into the gravity pressure loss term. And -- so you will have numerical fluctuations in the gravity term that result from whatever the selected time step size is. And so a -- but fundamentally there's just going to be some contribution from that numerical aspect of the solution -- that discretization in time space, and discretization in the axial nodalization. That means the level is going to fluctuate.

And I think this level fluctuation is going to produce sort of this sloshing, which for most safety analyses is not important. But for something -- if you're trying to use a systems analysis tool to predict the evolution of the boron concentration over a very long time, if you have some small amount of sloshing from -- that's a numerical artifact, it really presents a challenge to using that systems analysis to quantify how much you can credit that kind of mixing.

MEMBER MARCH-LEUBA: That's the -- the bottom line, it is a very difficult problem. But I wanted to put on the record that my intuition agrees with your intuition, Pete, that mixing is -- that the downcomer deborated water will mix with the upper plenum riser before it gets in to the core and causes a criticality. That's what my intuition tells me --

(Simultaneous speaking.)

MR. YARSKY: Right, yes. And Jose, if you don't mind, could I interrupt for just one second to make a very important clarification -- is that the -- the phenomena I was just describing in terms of the sloshing, is mixing -- of like the flow, comes out of the lower plenum and into the downcomer -- and then back and forth. And I want to differentiate that between the internal recirculation driven mixing to sort of clarify that I am talking about two different --

MEMBER MARCH-LEUBA: Yes, I understand.

MR. YARSKY: Two different phenomena there.

MEMBER MARCH-LEUBA: I understand. There will be physical phenomena that will enhance mixing. I asked Delphine, my intuition is sufficient for the blanket statement in the SER and the complete avoidance of a statement on the FSAR that operator actions cannot possibly cause any problem under these conditions.

I am with Walt when he says he's at allowing the lower downcomer to deborate is not the desirable condition. And if you want to allow it to deborate, you have to roll up your sleeves and do the little calculations to show that it's okay because many things can go wrong. Okay, I'm done.

MR. YARSKY: Okay. The -- so with that, I want to move on to question Bravo, which is about the all rods inserted condition. And you know, while the staff's white paper addresses an all rods out condition, for the most part, it does talk about in a few instances how things would change if the core was controlled, or partially controlled. I mean there will be some sections that try to address that configuration.

Here, with the -- if all rods are inserted, that population of control rods creates like a static, constant background negative reactivity insertion so that even if reactivity is being added, kind of a -- the rate at which you would need to add it is much higher to bring the reactor first to a critical condition, and then to insert enough reactivity that you have to -- that you would potentially challenge fuel damage limits.

And mixing -- this internal, recirculation-driven mixing is kind of always erasing the reactivity that you're bringing in. So the -- to -- for an all rods inserted case to have prompt reactivity excursion, the mechanism would have to just be faster than even what we considered for the all rods out. And so it's just -- we would perceive it to be a less limiting condition with all rods in.

MEMBER KIRCHNER: That makes physical sense, of course, Peter. Could you address, just for clarification, for the record -- you or Ryan -- for the Chapter 15 you assumed -- those analyses were all maximum where rod assemblies stuck out. Is that correct?

MR. NOLAN: Yes, that's correct.

MEMBER KIRCHNER: Okay, thank you Ryan. Yes. So that's an in-between all rods in and that really beyond-design basis analysis in your first white paper of LOCA plus -- plus --

MEMBER DIMITRIJEVIC: Well sir, I'd like to mention -- to ask for clarification here. Does this mean -- so this is a less limiting condition and we need the fast injection, but can this -- but can this happen, you know, the -- that activating charging or something?

(Pause.)

(Simultaneous speaking.)

MEMBER DIMITRIJEVIC: I mean my question is what type of scenario -- what type of the condition will the operator have to create the -- in the -- from the PMA perspectives do we have it also is a huge difference. We are talking 10 to minus six, 10 to minus five difference.

So therefore, would this scenario come to be important or not is extremely important on this answer. So is there -- you know, ever some condition which we discuss, like activating -- I assume the -- the flooding and drain system has too low injection rate. But can activating charging cause the issue with all rods in?

MR. YARSKY: So Vesna, we looked at a variety of mechanisms and tried to break them out into these transient versus prolonged --

(Simultaneous speaking.)

MEMBER DIMITRIJEVIC: Yes, I had seen that in the previous --

(Simultaneous speaking.)

MR. YARSKY: So because whatever happens has to overcome the negative reactivity that's provided by the -- the fact that the rods are inserted and they'll stay inserted, I think that you would only need to worry about the transient processes. And those tend to be not associated with operator actions. The operator actions for recovery would be these prolonged injection scenarios, which the staff contends are slow.

MEMBER DIMITRIJEVIC: I see. So basically on the -- on the -- on the record, in this -- cannot -- you know, we don't have to be concerned of the -- of the -- this type of matter in the -- all the --- we don't have OCWAS (phonetic).

(No audible response.)

(Simultaneous speaking.)

MEMBER DIMITRIJEVIC: If we do not have OCWAS, we don't have to be concerned about this type of --

MR. YARSKY: Well I think from a core damage perspective.

MEMBER DIMITRIJEVIC: Okay. Because then we have this discussion the last meeting that neither of those scenarios we showed there will -- if 10 to minus five and 10 to minus six, the frequencies will -- they're all -- they're all related to all rods in situation. Because as soon as you have rods out, you are in, you know, frequencies which are -- they're now 10 to minus eight or 10 to minus nine, depending on the type of LOCA. So when these scenarios were presented in our last presentation over this diverged opinion, those scenarios were related to no OCWAS scenarios.

MR. YARSKY: Right. And Vesna, to be fair to this point, if -- if one adopts the position that there is no internal recirculation and mixing does not occur, then whether or not the rods are inserted is not necessarily an important distinction because one would presume that as you're reflooding the system and you're inputting that deborated water into the core, and it -- if you assume it does not mix, then eventually you'll reach the point of criticality regardless of whether or not the rods are inserted. So you kind of get to the same point eventually if you were to take the position that there is no internal mixing.

MEMBER DIMITRIJEVIC: But that's not a point of contention, right? That -- everybody agrees that some level of mixing will be occurring, right?

MR. YARSKY: Right. So it -- it certainly is the -- the case that if the rods are inserted or are not inserted, if mixing does occur, then the rods being inserted is less limiting a condition. I would say, however, if one were to take the position that there is no internal recirculation-driven mixing, then the -- the two scenarios look more similar.

MEMBER DIMITRIJEVIC: Okay, I get it.

MR. YARSKY: Okay. And then for the time

being we would like to skip on question Charlie and move to question delta, which asks about the time ranges. And you know, like I will admit that the -- the staff originally set off to calculate what these time ranges would be using the TRACE LOCA model.

But as I alluded to in an earlier discussion, the TRACE model was predicting this level oscillation-driven sloshing between the core and the downcomer, which led to significant mixing between the downcomer and core concentrations. So we didn't want to rely on the TRACE calculation to address this question. And without the TRACE calculation, we have to resort to performing more hand calculations, or back-of-the-envelope calculations.

And unfortunately, such an approach necessitates making assumptions. And so we've tried to address this question of, you know, how quickly does the deboration -- or the boron dilution occur? And you know, how sensitive is that to nominal versus delayed ECCS actuation?

And we've developed a table of results. We looked at the amount of time it would take to reach 100 PPM based on a post-ECCS downcomer boron concentration and an assumed steaming rate, and calculate that that time frame would be about one day to one week. And then at the time to reach 10 PPM, we also calculated -- and that's something like on the order of one week to two months. And so I -- that's sort of the -- I know that that is a wide range. But with the hand calculations, I don't think we can give a better --

MEMBER KIRCHNER: Peter, why did you pick 100 PPM as a benchmark?

MR. YARSKY: So it's -- yes, this is relatively arbitrary. And I think, you know, you might ask, why don't you calculate it out until you get to zero PPM? When you never get to --

(Simultaneous speaking.)

MEMBER KIRCHNER: What's of interest to me is calculating when you get to below the critical boron concentration.

MR. YARSKY: Well you will be below the critical boron concentration while --

MEMBER KIRCHNER: I know and -- and what's of interest is the time intercept of that point.

MR. YARSKY: Right. So the -- when we did these calculations, we looked at what the downcomer boron concentration was, like immediately at the time when the ECCS valves open. Now when the ECCS valves open, in the immediate short-term aftermath there's going to be flashing in the downcomer, which is going to increase the concentration.

So it will go back above the critical boron concentration. But we would need to do like a systems-type calculation to -- to get that, because we would need to know how much flashing occurs. So we did not rely on the TRACE calculation. Instead we said, we're going to start from what the pre-ECCS boron concentration is. And then given a steaming rate, calculate how much that dilutes.

So it would -- in our method that we've used here in the hand calculation, the initial concentration is already below the critical boron concentration. Because we don't credit the increasing concentration from the flashing induced by ECCS. So it's conservative.

But then the -- the values of 100 PPM and 10 PPM, we said you're starting from somewhere roughly around 1,000 PPM, give or take, so this kind of represents like 90 percent and then 99 percent dilution. Like roughly -- roughly.

(Pause.)

MEMBER PETTI: So Peter -- this is Dave Petti -- just again, to clarify then -- instead of this idea of having just a -- a few hours time window, which is what we talked about -- our committee talked about a couple weeks ago -- this implies that it could be up to a day longer, depending on when the ECCS actuates.

MR. YARSKY: Oh so -- I think that, you know, maybe we -- that the research staff didn't fully understand what the committee wanted to better understand what these questions of the time range is. But I will go back to like an earlier discussion where we talked about the difference between extended DHRS cooling versus LOCA.

So in LOCA, you'll have a loss of inventory while the system is still at high pressure. So this is like a very small-break LOCA. And you can uncover the -- you can uncover the riser holes before ECCS. Because like we delay ECCS actuation, which leads to starting the downcomer at a diluted condition. So we might not be looking at the right -- the right thing.

If you're interested in how long do you operate on DHRS cooling before the downcomer reaches the critical boron concentration, I think that's -- that's a different question. I think that's been addressed in the previous meeting. But we're looking at this more from like a LOCA perspective.

MEMBER PETTI: Right. No, I'm looking -- I'm -- you know, the LOCA happens, the ECCS actuates, but you start to deborate. And in my mind, a clock is ticking because the longer you go, the lower the concentration in the downcomer. And if you have to do something, it's -- it's better to do it when you've got more boron in the downcomer than when you've got less boron in the downcomer. That was kind of the thinking that I thought the committee would have in trying to get an --

MR. YARSKY: Right.

MEMBER PETTI: -- understanding of what that -- that time window was to operate a recovery.

MR. YARSKY: Right, yes I think -- I understand. I understand that concern. I apologize that with the hand calculation I don't think we could really sharpen the pencil enough to give you an idea of how many hours before, you know, necessarily the boron concentration would reach the critical boron concentration.

Because as I said, we would need to use something like a systems analysis tool to get the flashing calculation right, which would then affect the -- sort of the starting point for the deboration in terms of the downcomer boron concentration. You know, using this simplistic approach we were able to calculate the times it takes to reach 100 versus 10 PPM, just to give an idea of the -- the time frames here.

Unfortunately, with a time frame like one day to one week, that puts you -- you know, 72 hours rests within that range.

(Pause.)

MEMBER PETTI: And Peter -- Dr. Yarsky, that indeed was our concern. As David Petti suggested, we're thinking that this suggests intervention before 72 hours. Unless one has high confidence that such an event is not going to happen and -- and that -- and the results would be benign.

MR. YARSKY: Well I think that there's a consensus that the boron concentration in the downcomer will decrease in LOCA scenarios.

MEMBER PETTI: Yes, to be sure.

MR. YARSKY: Right. So I think when -- when he said for this to occur, I think the -- when you're referring to would be some sort of perturbation, to use terms that we've used before -- some sort of perturbation that could disrupt the system in such a way as to challenge relevant limits.

MEMBER PETTI: Yes.

MR. YARSKY: Okay.

MEMBER PETTI: And you're contending, though, that really it's the mixing that is what really prevents this from becoming a serious event.

MR. YARSKY: Correct.

MEMBER PETTI: In the core -- mixing in the core.

MR. YARSKY: Correct, that when the --

(Simultaneous speaking.)

MEMBER PETTI: Based on the --

MR. YARSKY: -- deboronated water is transported into the core region, that it will mix with the inventory that's there.

MEMBER CORRADINI: So Peter, this is Corradini. I am most interested about the experimental analogues. With all due respect to calculations, I am more interested in that. And so those things reside within the -- the closed-session discussion, I assume.

MR. YARSKY: Well the slide packages, there's no sensitive information there.

MEMBER CORRADINI: Oh, okay.

MR. YARSKY: Because the -- the experimental evidence is from the open literature and PKL.

MEMBER CORRADINI: Oh, okay. But the PKL -- as I remember PKL, what you're basically saying is you're going to -- you're going to draw in water based on the internal circulation within the core. And that causes the mixing over some time scale that is short enough that you don't essentially get this wave-front effect.

MR. YARSKY: Well I wouldn't say that the internal recirculation is driving flow into the core. So you would -- you would have some kind of external mechanism that's pushing water into the core. But just once that water's in the core, I do not believe there's a way for it to be maintained as a static front that then propagates through the core. But rather that it will mix.

MEMBER CORRADINI: Okay, but then maybe I should say it more precisely so I understand your point. Your point is, I am in a recovery action I am adding at some rate -- I don't know what it is, but some rate. But that rate is such that the mixing essentially allows it to turn over and mix within the core due to these circulation patterns?

MR. YARSKY: Correct.

MEMBER CORRADINI: Okay. All right, thank you. And then the PKL is the example case that's most appropriate from an experimental standpoint, as I remember your discussion.

MR. YARSKY: Well I would say that the PKL test most directly measures the effect that the -- that this has on the distribution of the boron concentration spatially.

MEMBER CORRADINI: Okay, thank you very much.

MR. YARSKY: Because the PKL tests -- because the purpose of the test was the study of boric acid precipitation, you know, there were measurements made -- and redundant measurements made of the distribution of the boron concentration during the test.

MEMBER CORRADINI: Thank you.

CHAIR SUNSERI: So Walt, this is Matt. I just want to break in here, and I know we have more of this discussion to go. But I would like to start looking for a break point to where we can break for lunch. And then what I am going to propose is that we take a longer lunch break than normal. I am going to propose an hour and a half for lunch break, with the purpose of that being to give members some time to review some of this new information that is being posted to our SharePoint so that when we resume after the break, we will be a more informed of the discussion that is going to occur. Does that make sense?

MEMBER KIRCHNER: Yes, that does. And also we -- once the members have a chance to look at Dr. Yarsky's view graphs, we may not need a closed session. We've -- we've pretty much aired things. But if Peter or anyone else feels that's necessary, we can do that.

MEMBER RICCARDELLA: This is Pete. And you know, I've spent little time looking at the -- that view graph package. And as a non-thermodynamicist, it's Greek to me. And I just -- I can't make any sense out of the package without some explanation, I think.

MEMBER KIRCHNER: Yes. I think the summary is that there's ample evidence, and as Dr. Yarsky addressed Dr. Corradini's question, the PKL German facility was used to do good measurements of boron redistribution. They were worried about a different problem, and that was precipitation of the boron out of the system, but -- but the results of those experiments show good -- good mixing, which supports Dr. Yarsky's contention. A lot of the other experimental -- just for the public record -- the view graphs we're referring to have additional experimental information, all of which suggest that there's -- because of thermal-induced currents and such -- good mixing within the core region. And that would just be backup evidence for the -- for that postulation.

MEMBER RICCARDELLA: I believe we had a request in to NuScale to review those view graphs to see if they're anything -- if there is anything in them that really is proprietary and can't be covered in a public session. Maybe if we could have that --

(Simultaneous speaking.)

PARTICIPANT: Mr. --

MEMBER RICCARDELLA: In answer to that question before --

MEMBER KIRCHNER: I think we have an answer, Pete, already to that --

(Simultaneous speaking.)

MR. MOORE: Mr. Chairman? This is Scott Moore. So Dr. Yarsky said that there's nothing proprietary in them. But as of mid-morning, NRR was asking us to treat them as proprietary. Bruce -- and my request was to NRR. Bruce, has NRR made a decision on whether we should treat them as proprietary or not? The backup slides?

MR. BAVOL: Okay, for the backup slides --

this is not the white paper. They're still -- NuScale is still reviewing that paper --

MR. MOORE: Yes.

MR. BAVOL: -- for proprietary -- the backup slides have come back with no proprietary information. That information just came back to me. So --

MEMBER RICCARDELLA: So if we wanted to, after lunch, we could bring up those slides in the open session and have Dr. Yarsky go through them?

MEMBER KIRCHNER: Yes, I think we could do that, Pete. And he could probably quickly go through the -- the most important of those. Thank you, Bruce.

(Simultaneous speaking.)

VICE CHAIR REMPE: Could we have, before we break to lunch, the answer to question three, or -- yes, question three? It's not C, it's three I guess. And sometimes -- the instrumentation question. There's not a lot of text that I see. So I -- I don't think it's -- I'd like to have Peter there as well as the instrumentation folks because in Peter's paper, he often mentions the operators are looking at water level, whereas the -- I think the response is going to heavily rely on flex level type measurements. And I just am curious of -- it seems like the operators would like some backup with water measurements. Could we kind of hear their first response from the staff on it before we break for lunch, and make sure we kind of air a few things?

MEMBER KIRCHNER: Matt, are you amenable to one more question being --

CHAIR SUNSERI: Right, if they -- I mean if they believe they can answer it in a short -- you know, a few minutes -- period of time. We're not going to get in a long debate like we have in the past on some things.

MEMBER KIRCHNER: So I'll turn to the staff. Is -- I am -- I am not sure if this is Ryan or Dr. Yarsky, or someone else was going to address that question.

PARTICIPANT: Dinesh, are you on?

MEMBER KIRCHNER: Or Dinesh, yes.

(No audible response.)

MR. TANEJA: Yes, I am here.

(Pause.)

CHAIR SUNSERI: So question number three on the list -- are you prepared to answer that question now?

PARTICIPANT: Dinesh, this is the level instrumentation question.

MR. TANEJA: Well the level instrumentation is designed to be available in a post-accident scenario. Now the measurement uncertainties are calculated in the set-point methodology for those instruments for the pressurizer level range.

And even though it's the same sensor which measures the entire, you know -- the riser and the pressurizer. But the way right now the level of interest was the pressurizer level, so there's a calibrator span of the pressurizer level that, you know, is in the set-point methodology calculation where they have calculated the overall uncertainty which considers all the effects, including, you know, what the conditions are in a post-accident scenario. So that's the same sensor. So it is designed to be available to the operators with a known uncertainty. You know of measurement --

VICE CHAIR REMPE: Why don't you go ahead and say that number for the uncertainty? I don't think it's proprietary. It's in the FSA -- or the DCA document. It's quite high.

MR. TANEJA: It is high. Yes, I am not saying that it's not high. The total is proprietary -- that's in the set point methodology document.

VICE CHAIR REMPE: I thought the --

Chapter 7 of the SAR has like plus or minus? And I don't have it pulled up, but I thought it -- it's pretty high. And so I just kind of --

MR. TANEJA: Yes.

VICE CHAIR REMPE: -- wanting to hear Peter's response when he hears that number and -- is that going to give the operators good guidance when they could be off that much?

MR. YARSKY: So Joy, in the original white paper we considered a variety of operator actions. And I tried to put it in the perspective that without emergency operating procedures, a lot of the postulated operator actions that are there are just sort of like our speculation in a way. But the -- I think the specific section that you're referring to deals with, if there's a small-break LOCA, and then there's a failure of the rods to insert, and then there's a failure of the ECCS valves -- that the operators would diagnose that condition based on a continuing decrease in the level. And that in that specific beyond-design basis scenario, the operators will rely on the CVCS to provide makeup to the vessel to recover the level -- or maintain the level -- when ECCS is not available because it somehow failed.

VICE CHAIR REMPE: So again, I -- because

I don't have the Chapter 7 right up there, but again, there's a lot of uncertainty in those measurements. It's going to be very up and down-ish. We're talking about the guided wave -- you know, it's -- you're going to be relying on this and it could be off considerably. And if it's got, like, a lot of up and downing with the water level --

MR. YARSKY: Yes, certainly.

VICE CHAIR REMPE: It could -- yes, there's going to be a lot of things that need to be thought out carefully in such a situation, and the sensors -- because, a long time ago we didn't think the operators would need to figure out the -- rely on the water level within the --

MR. YARSKY: Well, it's like -- if I might continue, in -- in this --

(Simultaneous speaking.)

VICE CHAIR REMPE: Yes, please do.

MR. YARSKY: -- particular beyond design basis sequence, the -- you're relying on that injection because the ECCS has failed. So this occurs relatively early, you know, because you -- you really don't really start deborating the downcomer until after you've lowered the level below the riser holes. So it's at that point of ECCS actuation when you're going to really start lowering the level. So this will occur relatively early. And if the ECCS fails, that's when the operators would switch to the backup systems, which in this case would be maybe CVCS, to inject. And I think that the -- the boron redistribution issue just isn't significant because this would be something that would be done very early.

MEMBER KIRCHNER: Yes. Joy -- yes, this is Walt. I would concur with Dr. Yarsky. Pragmatically, once you entered into this kind of a scenario and you did your diagnostics, you would inject early and often. Trust me. That would be the response. You would go -- and -- with the CVCS system and just do that. So the -- the uncertainty in the level measurement is not really as important as the detection of the situation you're in -- and then intervening and injecting water. Do you follow my drift? The precision in that --

(Simultaneous speaking.)

VICE CHAIR REMPE: I can see what you're saying ---

MEMBER KIRCHNER: -- in that downcomer -- riser and downcomer is not an important factor in the operator response. What you will do is try and recover. And that will turn you to the -- the first line of defense will be the CVCS system. And the operating procedures. I am of course speculating, but I am pretty confident this is exactly what the EEOP would direct you to do.

(Simultaneous speaking.)

VICE CHAIR REMPE: So is section --

(Simultaneous speaking.)

MEMBER KIRCHNER: So you don't need a precise -- you don't need a precise level measurement is the point.

VICE CHAIR REMPE: Peter, are we talking about Section 3.6 of your first white paper where you mention flow reversal and void eruption? And having the level in the down cup over-swell? And flashing occurring? And it just seems like you're going to be -- the operators are going to be trying to rely on some instrumentation that isn't going to be giving you anything near -- it's going to be beyond inches. It's going to be in a feet level that you're -- that they may have some uncertainty. That's where I am talking about.

MR. YARSKY: So Joy, I was -- I thought we were referring to Section 6.7 which is the -- manual CVCS operation is ECCS backup. But you were -- you were talking about section 3 point --

VICE CHAIR REMPE: Six -- there's several places in your paper that you refer to the operators doing things, or monitoring things based on the water level. And I was --

(Simultaneous speaking.)

MR. YARSKY: -- yes.

VICE CHAIR REMPE: -- man, I don't know if I -- and again, I am not sure this can be dealt with now. I am back with what Dennis said. And actually what Anna had said a long time ago -- what can the staff really do at this time? And I guess it's going to be something that maybe the COL item is going to need to elaborate -- it would make me happy if they would elaborate a little bit more of what they expect to see the COL applicant provide to address some of these concerns raised in this discussion. And -- so anyway, I will let you answer the question about 3.6, but the discussion about the -- what I see in your second white paper is it kind of reflecting what I was looking at when I saw your first white paper about the instrumentation.

MR. YARSKY: Yes, so -- this is -- this is a very good point. And, you know, I think I could have done a better job in the white paper of clarifying what the -- the -- sort of the purpose and scope of the discussion of Section 3. So in Section 3 of the original white paper, the intent was to describe the progression of a -- of an event. This is the -- a kind of activity that the staff will often undertake to just get -- to look at an event progression and try and break that event progression down into phases because the phenomena that are important can vary from one phase of an event to another phase of the event. And in this description of these different phases of the event, I think that what causes that transition from one phase to another phase is very often dictated by where the reactor water level is. So for instance, if the reactor water level remains above the top of the riser, the flow conditions are very different, you know, and the phenomena that are important will be different under that condition than once the level drops below the top of the riser.

And I think in that discussion of the events, we talk about different potential operator actions. You know, but I -- I believe that the different operator actions would primarily be focused on trying to insert control rods. And you know, they would be a -- a generally, like a symptom-based approach to the procedures. So I don't think that necessarily the -- the operators would be relying on level instrumentation to identify which phase of the event they're in to then, you know, perform actions for that event. It was kind of meant more to be an exercise to help the -- the staff understand during which phases of the event different phenomena would be important.

VICE CHAIR REMPE: So you're saying the operator is going to rely on the symptoms of the event and -- what will they use to identify the symptoms of the event? Just flux detectors?

MR. YARSKY: Well I think that that will be -- like we'll -- it's going to be how the EOPs are crafted, right? So generally an EOP is crafted from the perspective of using a symptom-based approach. But you know, I -- I haven't seen the EOP, so I am not sure, you know, what the COL applicant will -- will come up with at that point.

PARTICIPANT: You know -- that's right, Peter. Typically, Joy, you know when they develop these procedures, they're -- then it's more symptom-based and -- and prescriptive a response. They're going to have other things at their disposal. They're going to see pressure in both the primary system and the containment. That's the first indication of a

LOCA that -- the ladder pressure measurement, et cetera. So they'll -- they'll have a number of things at their disposal that will trigger them to enter into the EOP response.

VICE CHAIR REMPE: So again -- I'm back to where I would feel a lot more comfortable if -- in -- that's something we can discuss later as a committee -- if we had a little more specificity of what we expect the COL applicant will provide because it seems like -- people are saying, well, I think it will be there. Yes, you're right. They'll have pressure transducers. But -- and they'll have some sort of flux detection. But what is needed to give the operator good guidance on how to say, yes -- and the staff as they review it -- that they believe that there is a way out of this event. And I will shut up there. But -- and we can look at the information we were given.

(Simultaneous speaking.)

PARTICIPANT: Yes, and Joy, this is a very important point -- oh, sorry.

CHAIR SUNSERI: No, I think we're into report preparation now, so we can stop this --

(Simultaneous speaking.)

MEMBER DIMITRIJEVIC: I would like to add something to this because even it wasn't the -- one of the question, which wasn't responded yet was the C about instrumentation, and the type of recovery action. I just want to say, when we are discussing these human -- the procedures and everything, this is okay, it will be done in the color phase. But design, which will help operators perform those -- you know, perform those actions, should be done in this phase. It's not something that applicant will be adding instruments, or the way to inject the bottom to this -- so it should be some general description of this recovery actions. What instruments they're going to use it, and how they're going to inject -- given all of this, you know, containment installation issues for their LOCA, OCWAS, how they're going to -- so this -- even those in procedures -- procedure will just describe operators do given the design agreement. So therefore, we need to have a description of this recovery action, knowing that the design is going to provide that we --

(Simultaneous speaking.)

CHAIR SUNSERI: So -- so that's good input for our letter report. I think, you know, we -- we know -- we have been given all the technical information that is available on this topic right now.

We can write our concerns in the -- in the report. So at this time I'd like to break for lunch. We are going to take an hour-and-a-half lunch break. We will reconvene at 2:30 Eastern Time. And when we reconvene, we will pick up with the question and answer period, which will involve a review of the slides that have been provided to the members -- applying here. And then I am told that NuScale has some technical remarks that they want to make following the Q&A. So we will allow some time for that. And then we will address any member final concerns and then move into report preparation. So any questions with where we are heading for the rest of the day?

(No audible response.)

CHAIR SUNSERI: Okay. Thank you and it is 1:00 p.m. We are recessed now until 2:30 p.m.

(Whereupon, the above-entitled matter went off the record at 1:01 p.m. and resumed at 2:31 p.m.)

CHAIR SUNSERI: It's 2:30. We are going to reconvene. I will begin with the roll call. Ron Ballinger?

(No audible response.)

CHAIR SUNSERI: Ron, are you on mute?

(No audible response.)

CHAIR SUNSERI: Dennis Bley?

(No audible response.)

CHAIR SUNSERI: Can anybody hear me?

MEMBER KIRCHNER: Yes, I can, Matt.

VICE CHAIR REMPE: Yes, we can hear you.

CHAIR SUNSERI: Okay. Charles Brown?

(No audible response.)

CHAIR SUNSERI: Well, I'm not going to give an hour and a half lunch break anymore, am I. Vesna Dimitrijevic?

(No audible response.)

MEMBER KIRCHNER: Matt, I'm concerned that perhaps you might have said 2:45 which is --

(Simultaneous speaking.)

VICE CHAIR REMPE: We're getting messages from Dennis that says he can't turn his mic on, although --

MEMBER KIRCHNER: Okay. That's the problem. Okay.

VICE CHAIR REMPE: Yeah.

CHAIR SUNSERI: Okay. So there may be something --

MEMBER BROWN: I've got it back now. Hey, Matt.

CHAIR SUNSERI: Yeah, yeah.

MEMBER BROWN: Somebody had muted us.

MEMBER BALLINGER: Yeah, this is Ron. I'm here.

MS. LUI: I just repeat the action of unmuting everybody. So everybody should be unmuted.

CHAIR SUNSERI: Okay. All right.

MEMBER PETTI: This is Dave. I'm back on.

MEMBER BROWN: Okay. You want to start over?

CHAIR SUNSERI: Let me start over. All right. Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley?

MEMBER BLEY: It works now. I'm here.

CHAIR SUNSERI: Okay. And I apologize about my comment of giving too long of a lunch break. Charles Brown?

MEMBER BROWN: I'm here.

CHAIR SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Here.

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Yes.

CHAIR SUNSERI: David Petti?

MEMBER PETTI: Yes.

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: Here.

CHAIR SUNSERI: And myself. All right. We have 100 percent available and a quorum. Let me just provide a couple of comments here before we get started and just take this in the vein of just trying to move things along here. So I do appreciate the fact that Committee members have a lot of concerns or some concerns at this point they're feeling unfulfilled.

I believe we're getting to the point of what I'll call diminishing returns on keeping to press the staff and NuScale for a resolution on all our concerns. And primarily, I think it's because as the design has progressed this far, it still has more to go. And what's left I think is where a lot of our questions remain to be answered. So continuing to press now for things that don't exist or not capable of being presented at this time, it's just not going to help.

So what I would suggest is that we as a member of the Committee need to be mindful that at the end of the day, we report to the Commission and we have to provide our recommendation on whether or not we support the staff with the issuance of a design certification or not. And so I think a lot of the discussion that I'm hearing is bordering on discussions that we need to be having in Committee along those lines and not having to debate those any further with staff or NuScale.

So Walt, what I'm going to suggest is that we proceed through the rest of the afternoon, hear from the staff on the rest of our questions, and hear from NuScale on the technical information they want to provide. And then we just have to move into our deliberations and decide for ourselves, have we heard enough from staff and NuScale? Have we seen enough of their work, and is the design sufficiently progressed at this time that we can make a safety judgment on the design certification, standard design authorization at this point in time? And we do that through our formal letter reports which are always factually based with conclusions that are derived from those facts. So anybody have any comment or anything they want to say?

(No audible response.)

CHAIR SUNSERI: Okay. Scott Moore, our executive director, wanted to make a point or two here before we got into it. Scott?

MR. MOORE: Thank you, Mr. Chairman. And this is for both the members and everybody else, all the other participants online. This morning, there were two documents that were discussed. One is backup slides by Dr. Yarsky. The other is a proprietary second white paper from Dr. Yarsky.

As you heard, Members, the backup slides are now nonproprietary, and those are being made available to members of the public. And we will make them more widely available soon. The proprietary second white paper -- and if NRR could confirm this -- I believe is being reviewed for -- and prepared in a nonproprietary version. And as soon as we get the nonproprietary version, that version will be made available as well publicly. Could NRR confirm that a nonprop version is being prepared?

MR. BAVOL: This is Bruce Bavol, Project Manager, NRR. Yes, currently NuScale is performing a proprietary review of the white paper from Dr. Yarsky. As soon as that information gets back to us, if there is any redacting that needs to be had, we will redact the paper and prepare a publicly available version and place that version into ADAMS and provide the ACRS membership with that information.

MR. MOORE: Okay. Thank you very much. That's all that I wanted to make everybody aware of, that we will make those documents available for everyone's benefit. Thank you, Mr. Chairman.

CHAIR SUNSERI: Okay. Thanks, Scott. And I know there was a little bit of anxiety around that today, and we appreciate the fact that a lot of this information is late breaking and therefore did not have the time necessary to go through appropriate review before we could make the public disclosures. But those are -- processes are being followed and the disclosures will be forthcoming.

So thank you for those clarifications and confirmations. At this point, I would now turn to Walt to continue facilitation of the Q&A with the staff, and then we will take member comments and then hear from NuScale and then try to wrap up the presentation of information before we roll into our report preparation. So Walt, go ahead.

MEMBER KIRCHNER: Just two comments, Mr. Chairman. Also we would like a very brief presentation of the backup view graphs now that we know that we can use them in an open session. And then we have to remember to allow time for public comment at the end before we break for our letter writing session.

CHAIR SUNSERI: Right, absolutely. Thanks for reminding me of that, Walt. Appreciate it.

MEMBER KIRCHNER: So turning to the staff, I think we had one question remaining if I'm correct. And I don't know if that's Dr. Yarsky or Dr. Nolan or who from the staff will take that -- finish the Q&A part of the session?

MR. YARSKY: Walt, this is Dr. Peter Yarsky from the research staff. Before lunch, we were discussing Question C --

MEMBER KIRCHNER: Yes.

MR. YARSKY: -- which we were prepared to discuss after addressing all the other questions. But I don't know if the Committee wants to continue discussion of Question C or if we should pick up with Question D.

MEMBER KIRCHNER: Let's go in order. Let's do C and D, and then I believe that's the list.

MR. YARSKY: Yes, I believe -- do we have Dinesh on the line?

MR. TANEJA: Yes, I'm here. Peter, can you hear me?

MR. YARSKY: And so I'm wondering if we have anything else to discuss with respect to Question

C.

MEMBER KIRCHNER: I thought we were finished, Dr. Yarsky. I thought Dinesh summarized things. There will be instrumentation to measure level. It will be qualified. I don't believe the applicant has made their final selection on instrumentation type. But I believe Dinesh answered the question, unless there's further comment from the Committee.

MEMBER DIMITRIJEVIC: The concern wasn't only about instrumentation. It was about what needs to be done and can this be done. So my concern, we all have idea what needs to be done. Only the question is, what does this -- actually, literally, what needs to be done, the description --

MEMBER KIRCHNER: Vesna, please could you narrow that down? A lot remain to be done.

(Simultaneous speaking.)

MEMBER DIMITRIJEVIC: This is what I'm asking. So how are we going to recover? That's my question. If we're going to recover, we're going to inject the boron. How are we going to inject boron? We have a containment ventilation signal in the case of the LOCA and ATWS. So my question is, what needs to be done basically, that this containment ventilation signal can be bypassed. And what else needs to be open? I just want to know what equipment is desirable.

MR. YARSKY: Yeah, so Vesna, I'll try to address this in a general way because, as we said, there's no procedure -- no procedure has been submitted for NRC review at this stage. But there --

MEMBER DIMITRIJEVIC: Right. And I'm not interested in procedure. I'm interested in equipment.

MR. YARSKY: Right. So the -- so equipment that will be available includes the CVCS and the CFDS which because of isolation signals would be available for injection but could only inject high concentration -- a high concentration of boric acid coolant. So think like 4,000 ppm, give or take. And the only other comment I think I would have to add is that there' nuclear instrumentation available and that could be used to monitor subcritical margin, as is done during startup.

VICE CHAIR REMPE: So I think when we left off before lunch, you had emphasized, well, there'll be symptom-based procedures when they're developed. And I guess where I'm still not sure and perhaps none of us are is how will the operators diagnose what condition the reactor is in during these types of situations so that they can say what needs to be done. And again, although as Walt pointed out, the actual sensors have not even been decided upon, their accuracy is specified in the DCA. And is that adequate with that range of uncertainty?

MR. YARSKY: This is Peter Yarsky from the staff again. I think just from a philosophical standpoint that monitoring subcritical margin during starting and monitoring subcritical margin during any hypothetical recovery maneuver I think would be fundamentally the same. And the same instrumentation could be relied upon for either maneuver.

VICE CHAIR REMPE: But you may not know what the water level is. And when you don't know that and you don't know, yeah, you'll have some sort of subcriticality flux detector that can monitor changes in the period. But you won't know whether that's due to voiding. You won't know what the water level is. I think there's going to be some uncertainty that will take a while to figure out exactly how you'll be able to, with some confidence, diagnose the condition of the patient.

MR. YARSKY: Right. I certainly think that they'll have to be -- like, some more work will have to be done at the point where these kinds of procedures are developed because it will depend on a lot more than just like this high level discussion. And certainly, like, how instrumentation readings are affected, for instance, but the environmental conditions, right? So instruments may develop environment-specific biases and uncertainties that would have to be considered. I just think that would have to be part of a later submittal.

VICE CHAIR REMPE: And the COL item --

MEMBER KIRCHNER: That's a typical product qualification.

VICE CHAIR REMPE: -- was kind of vague on -- I'm sorry. Are you talking to me, Walt? But anyway, I think the COL item as it stands today doesn't give anybody a clue of what's going to be expected from the staff. And if you need to change some of those accuracies since we've not really had a chance to think about this carefully.

MR. TANEJA: This is Dinesh. May I add something?

MEMBER KIRCHNER: Go ahead, Dinesh.

MR. TANEJA: Yes, so the way NuScale has proceeded with the instrumentation is that they have selected the types of sensors and they have theoretically calculated these uncertainties based on the environmental condition. Now these are not the actual numbers that would be based on the actual testing which they would do during the COL, I guess, construction stage. But the numbers that they have calculated are the numbers that are assumed in the accident analysis.

So it's like the accident analyses are based on assumptions which are validated by the -- in the calculation that are performed for the total loop uncertainties. Now the instrumentation information that would be available is your riser level, your pressurizer level, your pressurizer, reactor coolant pressure, reactor coolant temperature, and the nuclear instrumentation. So those instrumentations are designed to be available.

And to answer the question about the containment isolation signal override capabilities, yes, a design has the capability to override the containment isolation signal and selectively open flow paths. So this is all administratively controlled, and that's where the procedures are able to take advantage of these features that are there in the design.

VICE CHAIR REMPE: So just to be real specific, my understanding that the water level sensor in the RPV is similar to the one in the CNV. And they have a preferred one at this time. But the advanced sensor reports, it's very clear to say we've not finalized the qualification for that sensor. And they basically have relied on the specifications that the staff and the applicant have agreed upon for that sensor. Is that not a true statement, Dinesh?

MR. TANEJA: Right. So there is the manufacturer specification. And then what the NuScale did is they have basically based on some data that they have, they have come up with the assumed uncertainties during accident conditions, for example. So the overall total loop uncertainty that they have calculated has taken into consideration all the environmental impacts.

VICE CHAIR REMPE: And when they did this with the reactor vessel, this whole thing about boron dilution has not even come to light, that the operators would have to think about long-term recovery. That wasn't considered when that was all specified, right?

MR. TANEJA: Okay. So the thing is there are no manual operator action under the design basis condition. So there are no Chapter 15 events that require a manual operator action. So all the automatic actions that are relied upon, so that analysis assumes this uncertainty which bounds the uncertainty that's calculated based on the best available data at this time which would be validated during the EQ testing and seismic testing of the actual instrumentation. So --

VICE CHAIR REMPE: That's --

MR. TANEJA: -- what we have is we have a bounding uncertainty values which are correlating with what's assumed in Chapter 15 and then the analyses. So all your analyses are actually based on those. So the assumptions are actually conservative compared to what's calculated. So they --

VICE CHAIR REMPE: So that --

MR. TANEJA: -- just need to demonstrate that they stay within those assumed values.

VICE CHAIR REMPE: So those calculations were done before this whole boron dilution thing --

MR. TANEJA: Exactly.

VICE CHAIR REMPE: -- came to be. And so what I'm trying to get to is the question when Peter was doing his analysis, did he say, okay, the operator is going to be watching this in that section -- was it 3.6 I mentioned earlier, Peter? When you were talking about that flow and things going back and forth and voiding, did you consider that the operator may -- I don't know what. I guess we're not allowed to say the accuracy aloud.

I still haven't found that table during the lunch break. I was doing some other things. But did you consider the specific uncertainties that are allowed for that sensor when you said, oh, yeah, the operator will be able to detect that the water is up or down?

MR. YARSKY: So Joy, this is an excellent question. In the original white paper analysis, we just assumed that the operator would not monitor. It would just initiate the system and just allow it to evolve. But this is not a realistic approach. Realistically, the operators would monitor the condition as it evolves and would not just turn on an injection source and leave it one.

VICE CHAIR REMPE: And so if they are realistically monitoring that, that's where I kind of go, I'm wondering if they're going to have some confusing signals which has occurred in the past with real reactors that have had some severe accidents occurring.

MR. YARSKY: Right. I think that --

VICE CHAIR REMPE: And yeah, I guess I

really would like to see something stronger about what the staff would expect in that COL item.

MR. TANEJA: So Joy, for example, the boron redistribution issue, so the design change added a new ECCS actuation signal based on the reactor coolant pressure. So the analytical limit is 800 PSIA. What's assumed in the analysis, it's plus or minus 100 PSI.

VICE CHAIR REMPE: I'm happy with the fact they added the pressure signal to initiate ECCS.

MR. TANEJA: Right. So the --

VICE CHAIR REMPE: That's made me very, very happy.

(Simultaneous speaking.)

MR. TANEJA: So the analysis assumed 100 PSIA uncertainty for that value. Okay? So the analysis is actually run assuming a set point of 900 PSI plus or minus 100 PSI, where the analytical limit is 800. And the set point calculation that they performed is actually within that assumed 100 PSIA for that value under that condition.

Now the as built has to be done, and they had to assure that the assumptions are validated when they actually designed the instrumentation and test them. But this is what we found when we evaluated it, that the calculated uncertainties are bounded by the assumed uncertainties in Chapter 15 and then the analyses. I'm giving you an example. So they did the similar thing that all other automatic initiations that are part of Chapter 15.

VICE CHAIR REMPE: And even this is the standard analysis that Peter --

MEMBER KIRCHNER: Yeah, this question applies to all the instrumentation.

VICE CHAIR REMPE: -- has done.

CHAIR SUNSERI: Hey, Dinesh. This is Matt. I've got a question for you. I think this is accurate, but correct me if I'm wrong on this. I think as the plant gets closer to getting an operating license, there'll be an instrument set point and uncertainty analysis that will cover all of the instruments that are used in tech specs, that are used in the emerging operating procedures that the operators use to control the plant.

And that document gets reviewed by the NRC, I believe. And so therefore, that's a tool that's used to make sure that the operators aren't relying on anything that is not capable of performing within the range necessary to successfully complete the action. Is that right, what I'm saying?

MR. TANEJA: Right. So what we evaluated is a set point methodology document as part of the design certification. So their design certification is based on a set point control program which basically says that the actual values of the set points would be outside of the tech specs, controlled outside of the tech specs. So that program actually needs to be finalized before they can load fuel.

So that means they have to do actual set point calculations based on the installed as built conditions and the actual instrument data. And the numbers that they have in the set point methodology documents have to be validated by actual calculations that have to be performed during construction. And NRC inspects those calculations as part of our high tech inspection process.

CHAIR SUNSERI: So that seemed to be the safety net that would alleviate some of the concerns that are being --

MEMBER KIRCHNER: And also, all the equipment has to be qualified --

MR. TANEJA: Exactly.

MEMBER KIRCHNER: -- and calibrated.

MS. TURNER: Exactly.

VICE CHAIR REMPE: Well --

MEMBER KIRCHNER: Yes, and it doesn't -- it's not just level, Joy. It's all the sensors have to be --

MR. TANEJA: Right, the temperature, pressure.

VICE CHAIR REMPE: And all of these things were done for the DCA early on, and we reviewed it. Now we've got this additional concern. Were any changes -- other than I know you changed the set points on the containment water level and you added this -- NuScale added the pressure initiation methodology for ECCS.

What about reactor vessel water level? Have any changes been made? Or is the staff --did they look at it and say, oh, no changes needed to be made because of this boron dilution issues. That's where I'm trying to get to.

MR. TANEJA: The level instrumentation uncertainties remain the same because there really was not change to the consideration of any parameters that would have affected that measurement.

VICE CHAIR REMPE: Because of the boron dilution, the operators will not need any higher accuracy than what's currently going to be --

MR. TANEJA: That --

VICE CHAIR REMPE: -- available to them --

(Simultaneous speaking.)

MR. TANEJA: -- I don't know exactly what procedures would dictate and what their allowance would be on what information. The NuScale is aware of what the uncertainties would be on those measurements. So I think the operators know how close or inaccurate those numbers would be under those conditions. And they have to take that into consideration whether that information would be suffice or whether they need to correlate that information, corroborate that information, looking at all different data that they have available, temperature, pressure --

VICE CHAIR REMPE: And how will the staff know --

MR. TANEJA: -- containment level.

VICE CHAIR REMPE: -- to be sure?

MR. TANEJA: Well, that really is part of the EOP procedure. And that really runs into the COL stage of activity, right?

VICE CHAIR REMPE: Absolutely. It's a COL thing, but I just am wondering how the staff will -- is there going to be some note somewhere that will tell the staff, oh, in addition to what was approved on the DCA? When they finally figure out what they're going to do for the boron dilution issue, they need to think about sensors. That's where I'm wondering is there something written somewhere other than in our transcripts that says that, oh, they need to consider that too. And I think you're agreeing with me, Dinesh. You're saying --

MR. TANEJA: I am.

VICE CHAIR REMPE: -- no, that hasn't been looked at yet.

MR. TANEJA: Right. So the EOP stage is that they are developed by the COL holder, correct? So the EOPs do get validated on their functionality. And they have to recognize the limitation of the information that they have available that they rely upon to make some decisions. And right now, those procedures are not there. So really, they are evaluated by the staff during the construction phase before the fuel load, the EOPs are looked at.

VICE CHAIR REMPE: Just wish we had something that made me feel comfortable they would look at this issue too besides all the other requirements that are specified in the DCA.

MR. TANEJA: We --

VICE CHAIR REMPE: I'll shut up. I've taken up everyone's time enough on this. Let's go on to the next question.

MEMBER KIRCHNER: Yes, let's go on.

MR. YARSKY: Okay. So --

MEMBER KIRCHNER: Peter, I think it's back to you.

MR. YARSKY: Right. I was wondering if it might be worth taking a second. I would like to revisit this comment about the reactivity rate that Jose had brought earlier, having had time to think over the lunch break. And I think that using Jose's approach or the staff's approach, we ultimately would get to the same answer. I think it's just a matter of perspective. So I was wondering if I could take a moment to try and address that.

MEMBER KIRCHNER: Go ahead.

MR. YARSKY: So in thinking about how to sort of screen some of these events, in the original white paper, the staff would use linear approximations and calculations to try and arrive at a figure of merit that would be the time it takes to have one positive dollar of reactivity. And in doing that, we calculated sort of accidentally a reactivity insertion rate, though we say that that's not the best physical representation of the process. I agree with Jose that depending on sort of what the end points are of this calculation, you calculate a different rate.

So in the staff's calculation, it's looking at trying to calculate the time from critical to one dollar, that you add that one dollar of reactivity and then translating that into a time result. Using Jose's approach of looking at the reactivity when you have the actual condition of the reactor at highly borated and voided conditions where it's deeply subcritical, you would in like, a linear approximation, you would calculate a higher rate. But you would have to -- in order to get the time it takes to get to one positive dollar of reactivity, you would be dividing by then a larger delta K.

And I think that we would end up calculating the same number which is the number of seconds to get to positive one dollar of reactivity. And that's sort of the figure of merit for the staff's calculation. So I think that the confusion there is probably just in terms of thinking about that calculation that's aimed at developing that time in terms of a rate.

MEMBER MARCH-LEUBA: This is Jose. I don't agree with you, Pete, and I want to be even more nasty than that. I'm going to ask you a question. What you're saying, is this an opinion? Is it a hunch? Is it a gut feeling or a calculation? And you don't have to answer that. That was a rhetorical question.

That's my problem. I believe -- I honestly believe that if we put our heads to it and we do a scientific, thorough, detailed calculation which won't be easy, we could find that this design is okay. But we don't design reactors and accept the safety in the 21st century based on opinions, hunch, or gut feelings. And that's all I'm saying.

I have not seen any calculation. I don't see a process by which a detailed calculation will be supplied by the COL applicant because if the SER is published as is, it becomes a legally binding document, a legally binding document that says that no operator action whatsoever can possibly challenge the core. Why would COL applicant embark on a multi-million dollar research program to contradict the statement of the staff that favors them? And the COL applicant cannot, we've developed some new procedures. And accordingly, the staff told us that anything we do is okay. So here are the procedures, and we're okay. Prove me wrong.

MEMBER KIRCHNER: Yes. Jose, I think the -- let's stop there. The point is taken, and that's probably more appropriate for the Committee's deliberations than just throwing this back and forth to the staff or the applicant at this point. Can we go on to the last question, Dr. Yarsky?

MR. YARSKY: Sure. And Question Delta was about the time ranges. And as I've alluded to earlier, we tried to calculated that with TRACE but were not successful. And so we developed the hand calculations, and I believe we discussed this before lunch about the --

MEMBER KIRCHNER: Yes, you did, yes.

MR. YARSKY: -- time it takes to.

MEMBER KIRCHNER: And I think --

MEMBER PETTI: Dr. Yarsky --

MEMBER KIRCHNER: When you present your slides, perhaps you could address this in more detail again. I think your very last slide has your time calculations.

MR. YARSKY: Yes.

MEMBER PETTI: Dr. Yarsky, just for clarity, when you did TRACE, that was a 1D or a multidimensional calculation?

MR. YARSKY: Three dimensional calculation.

MEMBER PETTI: It was? Okay. Thank you.

MR. YARSKY: Now so if it would be to the benefit of the Committee, we can talk through some of the backup slides. And I think that was something that was raised as something that would be valuable. So we could do that.

MEMBER KIRCHNER: Yes. Okay. Are we -- Mike Snodderly, let me check with you because I've got a lot of things out in front of me. Have we gone through all the questions that were submitted?

MR. SNODDERLY: I'd like to also hear from the staff, but I believe you have. And if we could ask Peter to share his screen and bring those slides up, that would be great --

(Simultaneous speaking.)

MEMBER KIRCHNER: If we're through with the questions, let's go to Peter and the backup slides then. Okay.

MR. YARSKY: There is an additional question that the staff has not addressed yet on the PRA sequences. It was listed as a specific question.

MEMBER KIRCHNER: Okay.

MR. YARSKY: And so I don't know if you would like to have the staff address that question before going to the backup slides.

(Simultaneous speaking.)

MEMBER PETTI: I think it might be better to go through the slides first --

MEMBER KIRCHNER: First, I think so too, Dave.

MEMBER PETTI: -- to provide more context.

MEMBER KIRCHNER: Yeah. Peter, since you have the floor, why don't you go ahead and do those slides. If you could do them crisply, I know there's a lot of detail buried in there on test facilities and so on. But please go ahead.

MR. YARSKY: Okay. Marieliz, are you able to share the slides?

MR. BAVOL: This is Bruce. I'll take care of that.

MR. YARSKY: Okay.

MEMBER KIRCHNER: Christiana, do you need to make Bruce a presenter to do that?

MS. LUI: He's just made presenter.

MEMBER KIRCHNER: Okay. Thank you.

MEMBER BLEY: While we're waiting for the slides to come up, this is Dennis Bley. For the Committee, I don't want to talk about it here. But I'd recommend you take a look at SECY-96-128 and especially the SRM for that SECY. It's interesting. One day, we might want to talk about it.

MR. BAVOL: Can everybody see the slides?

MEMBER KIRCHNER: Yes, Bruce. They're up.

MR. YARSKY: Okay. So I'll try and go through these very quickly. If we progress to the first slide.

MR. BAVOL: Okay. I can't scroll through these.

MEMBER KIRCHNER: Peter, I think we have your first slide up with the overview of the test facilities.

MR. YARSKY: Oh, okay. Yeah, I'm not able to see that on my screen. But the idea in terms of developing a response to the question was to provide additional evidence of the internal recirculation flow pattern, in particularly, experimental evidence that that type of flow pattern and mixing could be expected to occur. And in doing that literature review, we identified a number of separate effects and integral effects tests that we think are relevant. And this sort of provides an overview of that.

And so this list includes, of course, separate effects tests in large diameter tubes as well as routed conditions and integral effects tests like CCTF and SCTF and PKL. In all of these tests, there's a consistent finding that there is a three dimensional effect of void channeling and the development of internal recirculation, particularly under pool boiling conditions and that these conditions can be expected to develop even under adiabatic experimental conditions.

However, of all of that, I believe the most compelling experiment to discuss is the PKL boric acid precipitation test that was performed as part of an international collaboration. And so if we could skip ahead, Bruce, to the PKL slides. And these backup slides do include some information about the other tests and the other test facilities and the findings. So I'm not able to see the slides on my screen, but are we sharing the first PKL slide?

MEMBER KIRCHNER: Peter, what we have are the three cross sections of the PWR postulated scenario, PKL at SOT and PKL test results.

MR. YARSKY: Yeah, at the start of the test, what is done is the liquid level in the downcomer is lowered and the two phase level in the core is lowered to uncover the hot leg. And then ECCS flow into the cold leg is manual in control to match the evaporation rate in the core. And this is done to minimize the mixing volume.

As I said, the purpose of the test was to study boric acid precipitation. So the idea was to drive the boric acid concentration to very high levels. So that's the condition of the start of the test. And then at the end of the test, the ECC flow is increased until there's a recovery. So if we go to the next slide, the next slide should show plots of the boron concentration at different phases of the experiment. The --

MEMBER KIRCHNER: That's what we're looking at, Peter.

MR. YARSKY: Yeah, the low level stage is sort of the middle of the experiment. And these measurements were done with conductivity probes as well as extracting samples of the fluid at discrete moments in time. So they're redundant measurements made of the boric acid concentration.

And these measurements are made above the core, below core, and around the core. And what we observe in the test is a relatively uniform and homogeneous concentration of the boric acid in the reactor whereas if this mixing was not taking place -- so if you were to think of it from a one dimensional perspective, the boric acid concentration in the bottom of the core would stay close to like 5,000 ppm and the boric acid concentration of the top of the core would continue to increase and would be much higher.

What we see is that there's a relatively uniform concentration above, below, and around the core. And so I think this is sort of the most direct evidence because the boric acid concentration was measured in those different locations to illustrate that the mixing takes place even when there is no significant flow. As I said, the ECC flow here is tuned just to match the boil off. So the thermohydraulic condition is very similar to what would be expected in the NuScale configuration.

(Simultaneous speaking.)

MEMBER BALLINGER: Peter, this is Ron Ballinger. Does the size of the experiment scale well with the NuScale dimensions that are important?

MR. YARSKY: I don't have a good answer for that question, Ron. This facility is scaled to look like a German convoy reactor. So of course, you know, if you were to think of the -- would this scale down to the NuScale configuration? One, the vessel height would be all off. So if you were to think, like, does this get the natural circulation right? It wouldn't.

However, I think that under the conditions that we're looking at, you have a pretty static level of, like, the RRV-ish elevation with very stagnant flow. So I think even though there is that scaling distortion, I don't think that would be very significant.

MEMBER KIRCHNER: Peter, this is Walt Kirchner. I actually know this facility and worked with it. This is -- to answer Member Ballinger's question, its full height in terms of core height. So those parts of the dimensions are about right. It's obviously not full diameter of the German reactor core. It was scaled more -- that's where the scaling took place. But the heights roughly are correct in terms of representing the primary system.

MEMBER BALLINGER: I guess I was more concerned with the sort of downcomer dimensions and things like that because are these dimensions large compared to the width of, say, the downcomer in the NuScale design?

MR. YARSKY: Well, Ron, I don't know how the downcomer dimensions specifically scale. But I don't believe the downcomer significantly interacts with the internal recirculation. And so the ECC flow is being manually controlled in the experiment. So in terms of what's going on in the lower plenum, I don't think that the downcomer scaling distortion affects the results.

MEMBER BALLINGER: Okay. All right. Thanks.

MR. YARSKY: There would be the question of the -- like, the barrel dimension relative to the riser wall dimension. But clearly in the experiment, that's smaller than you would see in NuScale. And so I think that you would have, like -- when the flow pattern develops, you have, like, the central core and then you have the periphery. I think it would just be wider in the NuScale case, but I haven't done any kind of specific look at the scaling distortion here.

The smaller the facility is, I think the more scaling distortion you add. But I think it would hamper the development of this flow pattern. So if you get really mixing in the small diameter case, I think you'd expect it to be better in the large diameter case.

MEMBER BALLINGER: And that would go for the lower plenum as well?

MR. YARSKY: Yes, that would go for the lower plenum as well. But I don't think that the lower plenum has as a significant of role to play as the active core region.

MEMBER BALLINGER: Okay, thanks.

MEMBER MARCH-LEUBA: Let me just offer a comment. This is very promising. But as a good mathematician would say, this is necessary but not sufficient condition. I can show you plots of test facilities where you survive a LOCA perfectly. But we still analyze LOCAs. Just because there was one reactor in Germany that run a LOCA simulation and the LOCA was good doesn't mean we don't analyze LOCAs. And I'll leave it there.

MEMBER BROWN: This is Charlie Brown. To echo Pete's question a while ago, for those who are no thermohydraulically initiated that much. You have two questions. What is the relevance of the curve? What's it telling us? I have no idea. I know the concentration.

Is there a limiting concentration or is there a minimal that we should? And has SOT start of the transient and EOT end of the transient? And is CVCS operating during this because it says so up at the very top and in one of your little boxes?

MR. YARSKY: So Charlie, to address those points, what's being measured here is the boric acid concentration.

MEMBER BROWN: Yeah, I got that.

MR. YARSKY: The test was to look at precipitation. So the test was run specifically to get to very high boric acid concentration. So you can see here that this is in, like, the 20 to 40,000 ppm.

MEMBER BROWN: Why is that? What's the nominal value you would have in the plant as it exists today in the NuScale --

MR. YARSKY: So under sort of this postulated boron dilution case, I think you're talking more in the range of, like, 4,000 to 10,000 ppm.

MEMBER BROWN: Okay. The bottom part of the graph in other words?

MR. YARSKY: Right. So it's certainly, like, a different range of boron concentrations. But the purpose of showing this test is, I think, in this case because the boric acid concentration was measured during the test. What I'm taking away from it is not what the value of the concentration is, but the relative value of the concentration of the core inlet, the core outlet, and the core periphery which we can see is relatively uniform.

(Simultaneous speaking.)

MR. YARSKY: So what this is indicating is that it's mixing. Now the CVCS --

(Simultaneous speaking.)

MEMBER BROWN: The curves -- what you mean by that is the curves overlay?

MR. YARSKY: Right, exactly.

MEMBER BROWN: Okay. But I'll also ask CVS is on during this, is it? Is CVCS on --

MR. YARSKY: Yeah, CVCS is operating in the cross overlay at these specific points that I marked.

MEMBER BROWN: Is it through the whole --

(Simultaneous speaking.)

MEMBER BROWN: -- time or is it just through a certain time? I couldn't tell that.

MR. YARSKY: It's just for certain times that are --

MEMBER BROWN: For five, six, and seven?

MR. YARSKY: -- indicated by the --

MEMBER BROWN: Five, six, and seven brackets?

MR. YARSKY: I would say it's during four, five, and six.

MEMBER BROWN: Okay. I'm looking at the little boxes which say, increase by injection from CVCS down at the bottom. It doesn't tell me over what box it is. So you're saying it's roughly four, five, and six?

MR. YARSKY: Yeah, you can see when the CVCS is on if you look at the -- do you see where it says, injection with CVCS and --

MEMBER BROWN: Yes.

MR. YARSKY: -- cross overlay?

MEMBER BROWN: Yeah.

MR. YARSKY: And there's some shading underneath.

MEMBER BROWN: Okay.

MR. YARSKY: That's when CVCS is injecting.

MEMBER BROWN: That's the brownish shading?

MR. YARSKY: No, I would call it blue. It's underneath. It says, injection with CVCS in crossover leg. And then immediately beneath that, there's a white band with blue shading at certain points.

MEMBER BLEY: Charlie, up at the top, right under the top.

MEMBER BROWN: I saw that. I got that, Dennis. That's why I was asking the question. But I didn't know what's the white. It's not on then. It's only on during the blue parts.

MR. YARSKY: Right. But let's say, like,

in terms of the boundary condition that's key here is that the -- even with the CVCS on, the ECCS flow is being adjusted so that you're maintaining constant inventory.

MEMBER BROWN: So that's not representative of the NuScale --

(Simultaneous speaking.)

MR. YARSKY: Even though you have injection here with ECC injection, what's happening is it's maintaining a level. And so that's why I think it's actually a lot like NuScale.

MEMBER BROWN: Okay.

MR. YARSKY: Because, like, you'll have the steam leaving through the hot leg and then through the break whereas in NuScale, that steam would be condensed in containment. And that'd be kind of like acting like the sump would act. See, you end up having a consistent level in the downcomer. So I think it's pretty analogous.

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: It is analogous to NuScale operation before you turn CFDS on. I mean --

MR. YARSKY: Yes.

MEMBER MARCH-LEUBA: -- you're presented with a steady state operation and ECCS cooling.

MR. YARSKY: Right. Jose, that's a very good clarification. Yeah, I'm talking when there's no injection. So this is just when you have just the natural circulation, yeah.

MEMBER MARCH-LEUBA: No one is claiming that the core deborates during ECCS cooling before recovery. As I said, this is excellent. This is good data. If you have not contained constant boron or semi-constant boron concentration here, you could not possibly hope to do it in NuScale. In my opinion, it's not sufficient. It's promising but not sufficient.

MEMBER BROWN: My other question, is CVCS working during this -- on the NuScale during this concern about deboration or is it off? Is it not injecting or injecting?

MR. YARSKY: I think the worry --

MEMBER KIRCHNER: It's not. It's been isolated.

MR. YARSKY: I was going to say I think the worry is that the downcomer would dilute and then at some future point in time yet undetermined, the operators would begin a CVCS injection. And that by virtue of that CVCS injection, that diluted water would be transported into the core.

MEMBER BROWN: It will be driven down in other words?

MR. YARSKY: So there's a period of time where there's no injection and operators are taking no action. And after ECCS, the downcomer begins to dilute because the core and the DHRS are acting kind of like a distiller.

MEMBER BROWN: Yeah, I understand that part of it. I was trying to figure out what role CVCS played. You just told me that tends to exacerbate it. If you do it early, is it positive? And if you do it late, it's negative? That's what you just kind of said.

MR. YARSKY: Well, so if the downcomer dilutes and then it never transports, then it's not impacting the core. If the CVCS is used in some way to increase the level -- and that procedure hasn't yet been established. But that would have the potential to transport that diluted water from the downcomer into the core. And I believe that's the synthesis of the Committee's concern.

MEMBER BROWN: What if it started earlier? Is it a procedural issue?

MR. YARSKY: I believe that if you -- that the potential concern would be exacerbated the more diluted the downcomer is. And so there would be a timing element.

MEMBER BROWN: I guess my question is if early in the transient, instead of waiting to actuate CVCS if you did it early, is that a positive or a negative effect?

MEMBER KIRCHNER: I --

MEMBER BROWN: I'm trying to figure out a way to get us out of this mess.

MEMBER KIRCHNER: No, no. This goes back to what I was saying earlier. Yes, earlier intervention is better.

MEMBER BROWN: Well, we went through the return to power thing on stuck rod, and we walked our way through operator actions. They can drive the rod in and do all this good stuff. And now we're sitting here not taking advantage of any possible operator actions that would mitigate this and allow those who are concerned about return to power like I am in this situation. It would allow us to accept it.

I'm trying to look for a way that we used on the return to power for stuck rod in a similar matter that you do for this circumstance. That's all I was -- that's -- again, I'm not first in thermohydraulics. But based on your all's conversation for the last two hours, three hours, it's been back and forth with all these nuances as opposed to what can you do to fix it as opposed to extra instrumentation and fixes to that and fixes to that. If you can turn the stuff on early, it sounds like you can possibly resolve it. I don't know if that's right or not, but that's just my perception based on listening to everything.

CHAIR SUNSERI: But Dr. Yarsky, this is Matt. I just want to make sure I understand this. Independent of whether you do start core flood and drain system early or late or add boration to the downcomer area early or late, what this data is showing is that during the distillation process, the boron concentration stay relatively constant. And when you have CVCS injection in the crossover leg, it doesn't necessarily disrupt that equilibrium that much. Is that how I'm reading this?

MR. YARSKY: So Chairman, I wouldn't -- like I want to focus a lot on the CVCS injection in the crossover leg in terms of interpreting the results here because any injection is going to be -- will have some compensation in the ECCS injection to maintain a constant inventory.

CHAIR SUNSERI: No, I mean, that's good,

though, right, because that's what's happening in the NuScale design, right?

MR. YARSKY: Right. And so like I would instead focus in terms of the message I'm trying to communicate here is that in this facility, the uniformity of the boron concentration and these different regions around and in the core is demonstrating that there is some mixing process that's ensuring that the concentration is relatively uniform, even when there is very, very little total flow rate. So this can only be occurring if there's some sort of internal recirculation to distribute that boron to maintain that relatively uniform distribution.

MEMBER KIRCHNER: And if I might add, Dr. Yarsky. This is Walt Kirchner. Matt, this experiment is part of a long series of experiments done at PKL, mainly addressing ECCS performance in a PWR. And what you're seeing here is as Dr. Yarsky pointed out. That's of interest for -- and relevance to the NuScale design is the period between four and six where this is an electrically heated core.

So they're running it at decay heat. They've got a decay heat profile, and they'll run the experiment through. So you've got a thermal source even under low flow rates to stimulate mixing in the core. And so I think the takeaway here is that in that band between four and six, you see from their sensors that the distribution through the height of the core is essentially about the same within experimental error.

CHAIR SUNSERI: Yeah, I understand that, but one more question. So what is the source of the ECCS fluid? I mean, is it coming off a borated source? Is it --

MEMBER KIRCHNER: Yeah, this is borated. And what they were doing in the experiment is they're running a profile, a simulation of how the ECCS systems would function in a large PWR under a LOCA scenario. And so you see the ramp up in boron because there, the ECCS systems are injecting boron. This is much higher.

And look at where the scale is, as Dr. Yarsky pointed. This is under reflood conditions. Now the boron concentration is much, much higher, almost, what, a factor of well over -- well, let's see -- six, seven, eight times normal concentrations. And the problem that they were worried about was precipitation, that all of a sudden, they would hit a condition and all the boron, the boric acid would just precipitate out into the lower plenum.

CHAIR SUNSERI: Right. No, I remember those concerns. But I'm just trying to make sure I understand the experiment here and what the data is showing me. So thanks for the explanation.

MR. YARSKY: Yes, absolutely. Thank you, Walt.

MEMBER PETTI: I just had a -- I want to make sure I understand it in my words. What the experiment shows is that there is this internal recirculation flow that mixes all the boron, even at what are normally very low injection rates into the downcomer that are sort of matching the steaming rates, not that dissimilar from NuScale. Further, the other slides that you skipped show similar recirculation flows and under other conditions smaller in scale. And so it's this experimental evidence that you are relying on to say that mixing -- internal mixing in the core and riser will occur and that a wave front type physical model is just mental picture to figure out what happens in this situation. Is that --

MR. YARSKY: Yeah, so I would say that we've looked at a variety of integral and separate effects tests that we think are relevant that demonstrate this phenomenon. And the idea of a propagating front, we don't think that that is the best physical paradigm to try and understand what would occur during a flow incursion. And it would be very important to consider this internal recirculation driven mixing.

MEMBER PETTI: And so this is what's the basis of not a significant reactivity excursion if the water in the downcomer were to come into the bottom of the core.

MR. YARSKY: Right. The idea is that if downcomer water comes in relatively slowly that it will mix and that you won't have a persistent reactivity accumulation.

CHAIR SUNSERI: So I -- so this is -- I don't want to sound too legalistic but this comment or this question, it sounds to me like what we are -- what you're describing here is the fact that in absence of a detail analytical conclusive result you're using these kind of engineering analysis and experimental datas relevant to the case to make a case that you are reasonably assured that that's going to happen in this particular reactor design and that's what you're basing your decisions on. Is that saying too much?

MR. YARSKY: Well, Chairman, I would add

that, you know, we have calculated the internal recirculation flow pattern in TRACE and that's part of, you know, what went into the -- into the white paper.

So I would say that internal recirculation is predicted by the systems analysis and I think that it's supported by this experimental evidence that would indicate that that pattern should physically develop.

You know, I think apart from that there are --

MEMBER KIRCHNER: Dr. Yarsky?

MR. YARSKY: Yeah.

MEMBER KIRCHNER: Can I add something here? This is Walt Kirchner. Matt, to his, Dr. Yarsky's, comment about TRACE, TRACE actually run in the 3D mode would do a reasonable job of predicting recirculation patterns.

What we heard about before lunch was tracking boron because of numerical dissipation, which is a different problem. But as far as predicting mixing patterns in an open core like this, TRACE would do a reasonable job of predicting that kind of phenomena.

CHAIR SUNSERI: Yeah, sorry. I am sorry

if my question was too overly simplified here. I mean, you know, in the global analysis, right, we don't have the full systems-based analysis that describe how the boron mixes and what the reactivity insertion rates are and all that stuff.

But we would be more comfortable, if you will, if we knew that there was good mixing going on coming into this core, based on everything else we have heard about and know about this core.

If we knew -- if we had better assurance about that, that would help us alleviate a lot of our other concerns at this time. That's all I am trying to say.

And so what we are using this analysis here to give us that somewhat assurance that there's going to be reasonable mixing going on here.

MR. YARSKY: Right, and I think that's a very good point and I would like to stress this is that, you know, when you're using systems analysis it's very important to understand, you know, what the limits of that analysis are.

I mean, you still have a computer code that you're exercising and you still need to interpret the results that are coming out of it, and while I believe research was comfortable with the idea of using TRACE to predict this internal recirculation pattern and can substantiate, you know, with this experimental basis why that internal recirculation flow pattern is real, there are other problems with using systems analysis to try and do a full-blown tracking of the boric acid concentration redistribution.

You know, and we have tried to use TRACE to look at some of the committee's question in more detail but run into, you know, some issues where it looks like numerical considerations can introduce these artificial perturbations that sort of compound. Then it becomes difficult to use systems analysis to answer some of these questions in a more direct way.

MEMBER BALLINGER: Peter, this is Ron again.

Is it your judgment that any scaling errors that might exist between the NuScale design and this experiment are sufficiently, what do you want to call it, small so that these results are not invalidated by scaling errors?

MR. YARSKY: So, Ron, in my opinion, the scaling distortion is going to be introduced by the diameter of the barrel and I believe that the scaling distortion would result in the experiment predicting a less uniform distribution than you would expect in the prototype.

MEMBER BALLINGER: So you're also saying that the ratio between, say, convective and diffusional and other mass transport mechanisms are about the same?

MR. YARSKY: Right. So the -- you're going to have -- so, like, the way those are going to scale is going to be by height and power density and those are relatively similar. I mean, they are not exactly the same but you're not talking about a factor of two scaling. You're talking, like, the percentage.

MEMBER BALLINGER: Okay. Now, within the core --

MR. YARSKY: The scaling distortion here.

MEMBER BALLINGER: -- their fuel, if I recall, is just standard, I think, AREVA fuel. It's got flow trippers in its cross flow. But the fuel design itself doesn't introduce mixing errors between the two experiments?

MR. YARSKY: I am not the greatest expert about how the heater rods were designed for PKL. But I am under the impression -- and, I mean, Walt will be able to correct me if I am under the wrong impression. But the PKL experiment is designed to be comparable height and to look like a commercial PWR fuel product.

MEMBER KIRCHNER: Yeah, and they used commercial spacers, if I remember correctly. So it's very similar to the German fuel and that's not that different under these flow conditions. The mixer -- the mixing veins that are the -- kind of the black art of spacer grids --

MEMBER BALLINGER: Yeah.

MEMBER KIRCHNER: -- which each fuel supplier develops help with things like critical heat flux at very high flow rates and such. But these -- here we are looking at a reflood flow rate measured in inches per second or less, and --

MR. YARSKY: Yeah --

(Simultaneous speaking.)

MR. YARSKY: -- if you think about it.

MEMBER KIRCHNER: -- so it's an open -- it's an open -- it's just an open -- how should I say it? These are not ducted like a BRW. It's an open lattice, and so they are prototypical mixing grids, prototypical size rods.

So the first order of things like cross flow and such under reflood conditions would be very similar hydraulically to that of the actual reactor.

MEMBER BALLINGER: Thanks. Okay. I am

just trying to get a handle on any sources of error.

MEMBER BLEY: This is Dennis Bley. This morning when you introduced your physical description you talked about working up a characteristic timing for the introduction of reactivity increase in a characteristic time for mixing, and, roughly, can you tell us those characteristic times? You've given us a lot of stuff to look at and I am -- I can't say that I've digested it all yet.

MR. YARSKY: Yeah. So we calculated the internal recirculation flow pattern with TRACE and derived a mixing time of about 40 seconds. And so what we tried to do in the original white paper was to calculate the amount of time it would take to have inserted enough reactivity to reach positive one dollar of reactivity, and in that calculation, of course, we assumed, like, it's a propagation of a front, you know, develop this reactivity insertion rate to calculate these timings.

And so for CFDS injection with both trains operating, when we calculated that time it was I think about 80 seconds.

MEMBER BLEY: Okay. Thanks.

MR. YARSKY: Or no, it was 39 seconds. Thirty-nine seconds with both trains. So it was comparable to the mixing time.

MR. CORRADINI: So, Peter, this is Corradini. Both trains means you would only need one train or you would expect not to do more than one train at a time, right? But you assume both trains are operating at full flow?

MR. YARSKY: Right. So it's sort of like the max. We looked at CVCS injection and CFDS injection and, like, what could give you the most -- like, the most oomph.

The most oomph is going to be from both CFDS trains operating together and when we looked at that, that amount of time it would take to get the positive one dollar was about 40 seconds, which is comparable to the mixing time.

MEMBER MARCH-LEUBA: If we have any questions, can I ask a process question, Peter?

Based on your -- on your judgment on -- so hand calculations, the staff has written an SER and is about to publish it that says no operator action whatsoever can possibly cause damage to the core.

I believe there's expectation of -- I mean, I find that -- I just thought that conclusion a little unconvincing because it's not thorough enough or detailed enough.

The expectation of some of the members I've talked to is that during the COL phase we will actually do more work to ensure that these carefully -- these hand calculations are correct.

But we will have an SER which is a legally binding document that says the operator can do anything they want but nothing will happen.

What will prevent a COL from developing the best procedures they can come up with and say, we are not going to do an analysis because the staff told us that these procedures are good because anything that the operators can do is good?

And I don't see what if occurs -- I mean, if the staff at the time still remembers that this is an issue, an issue in REI, saying what will happen if the COL can work with the SER and say, you already looked at it and Peter said nothing happens. Why do you want me to spend a million dollars for a testing facility to do this.

MR. YARSKY: Yeah. So, Jose, I think this is a really good point and this is something that in the white paper we did include some verbiage to try and sort of think about this issue.

For instance, one might postulate malicious operator and, you know, I have enough confidence in operators that if they wanted -- if they purposefully wanted to damage their core that they could come up with a sequence of actions, adverse actions, that they could take that could do that.

You know, and I might not be creative enough to think of what those actions are but a competent qualified operator I think would have enough knowledge to do something like that.

But I don't think it's reasonable to postulate the malicious operator assumption.

MEMBER MARCH-LEUBA: Oh yeah. Nobody's talking about sabotage here.

MR. YARSKY: Right. So I think it's -- well, it's -- well, they tried to consider in the scope of the white paper what we consider to be, like, reasonable assumptions about potential operator actions, and I think that, you know, I will have to defer to NRR who, of course, drafts and writes the SE based on the information provided by research.

But if the language is as strong as there's no postulated operator action, that language might be -- might be too strong and maybe worth taking another look at.

But, you know, we tried to focus on what we consider to be -- you know, even though we don't have the procedures, you know, what reasonably might an operator do.

MEMBER MARCH-LEUBA: The SER will become a legally binding document in about a month or two. Says there is no possible operator error of commission that would cause core damage and it's based on one PKL test that is not even close to what's happening when you turn SER on and your gut feeling that surely, we have to mix, and my gut feeling is that the COL applicant is not going to spend a million dollars on its product when they have a legally binding document that tells them that they can do anything they want with their procedures.

MEMBER DIMITRIJEVIC: Jose, can you give me reference and then where does it -- you said the 19.4. -- I did not find that. I did not run into this and I am trying to find it now in SER. What was the section?

MEMBER MARCH-LEUBA: You have to look at the new version of the Chapter 19, the one with the changes -- track changes.

MEMBER DIMITRIJEVIC: Not the -- not the -- okay. Not the one from December but the new one?

MEMBER MARCH-LEUBA: Correct. I mean, to add insult to injury, that paragraph where it says on this is not something, oh, that they forgot to change. It's something they added on purpose.

I mean, I just -- tell me why, somebody from the staff. I mean, let's not beat around it. Somebody from the staff tell me why the COL applicant will now come back and develop some procedures, the ones they want to develop because they are the cheapest to implement, and they will say, I don't have to analyze anything because the staff told me I could do anything I wanted, and it's in this legally binding document. Tell me why you want to do that.

MR. YARSKY: Jose, if you'll give me a moment, I will confer with the staff for a second because I don't think I am the right person to address this question.

CHAIR SUNSERI: Let me -- let me jump in. I don't think that's a fair question to ask the staff because it's asking -- it's asking the staff to speculate what an applicant might do and that's not their job.

So their job is to, you know, apply the regulations and that's what they are doing. They can't speculate of how an applicant might want to use or misuse whatever authority they've been given.

MEMBER MARCH-LEUBA: But when they write

an SER they should evaluate how this SER will be implemented. What is the consequence of the staff's actions? I mean, I know it's not fair. I know it's malicious. I know it's a question you don't want to answer. But this --

CHAIR SUNSERI: I think we are ignoring a lot of the other checks and balances that go into the licensing process. This design certification is not a license.

There's going to be all kinds of additional approvals necessary before this reactor get operated. They are going to have to write the EOP, emergency operating procedures. They are going to have to validate those procedures.

The regulator is going to review those procedures. There's going to be systems that design is going to be completed on that hasn't been completed.

The NRC is going to review those things. There are a -- there is -- this reactor is so far from being licensed that I think, you know, to say that -- I think that's the reason why these procedures are vague to us right now because the design has not progressed along to do that.

When it does, it will be validated. The

questions that we can't answer -- the questions that we ask now that can't be answered will be answered later and the licensing process, the COL applicant and the NRC's review of that application will address those at that time.

MEMBER KIRCHNER: Peter, this is Walt Kirchner again.

Do you want to show your last view graph of this set or are you finished at this point?

MR. YARSKY: We will leave that to the discretion of the committee. I am happy to talk about the timing calculation that's represented in the last slide. But I think it's only worth the committee's time if the committee thinks it's worth the time.

MEMBER KIRCHNER: Well, just please explain what we have in front of us on that last slide so the committee understands what was done.

MR. YARSKY: Okay. So if we go to the final slide it says timing of downcomer dilution, and this was to address the specific question delta, and in these calculations we -- first, we attempted to use TRACE.

But as I alluded to in the post-ECCS period, we were getting what we believed to be nonphysical results for downcomer boron concentration.

So instead we relied on TRACE to calculate everything up to the point of ECCS and this is where we get the time of ECCS actuation. We were able to do a nominal actuation at 1,700 seconds for a small break LOCA and then delayed the actuation by lowering the RPV pressure subpoint to, first, 600 psi and then 500 psi, and by delaying the ECCS the initial concentration in the downcomer was lower at the point of ECCS actuation.

Then from that point, there would be flashing that would increase the downcomer concentration. But we have conservatively did not credit that.

Then for decay heat power levels, we translated that to a steaming rate, and based on that steaming rate we were able to perform a hand calculation for the amount of time it would take starting at that given boron concentration and given that steaming rate how long it would take to reach two fixed concentrations.

The first is 100 ppm and the second is 10 ppm, and this corresponds -- I mean, not exactly but kind of roughly to about 90 percent dilution and 99 percent dilution.

MEMBER KIRCHNER: Thank you.

MEMBER MARCH-LEUBA: Just for reference, the CBC, critical boron concentration, is not 90 percent dilution. It's a proprietary number because they gave it to us prior to presentation but you guys know the answer. It's not 90 percent dilution.

MR. YARSKY: Right. Right. So, Jose, this is -- this shouldn't be -- these numbers should not be construed to say this is when you get critical boron concentration.

So we didn't -- so we did not provide what the numbers are relative to critical boron concentration on this slide. But if you know what the critical boron concentration is you can see how that value compares relative to the initial concentration and it only goes down from there in our hand calculation.

So we don't credit the concentrating effect of flashing. So, hopefully, you know, if you know that critical boron concentration you'll see why we then report that time.

MEMBER KIRCHNER: Members, further questions of Dr. Yarsky?

MEMBER PETTI: Walt, I just want to thank him. I thought these slides were, I think, important for us to hear to understand the thought process of the staff, both the first white paper and now the second white paper, and how they got to their reasonable assurance finding. It helped me a lot.

MEMBER KIRCHNER: Yeah. Thank you, David.

Yes, thank you, Dr. Yarsky, and also Ryan Nolan. Thank you for responding to our questions.

Okay.

MR. YARSKY: Could I then pass the baton to the NRR staff to address the final question --

MEMBER KIRCHNER: Yes, please.

MR. YARSKY: -- that was specific to the PRA? I believe that Marie posed that question.

MEMBER KIRCHNER: Yeah, who's the PRA question?

MS. POHIDA: Thank you, Pete. May I begin?

MEMBER KIRCHNER: Yes, go ahead, please.

MS. POHIDA: Why, thank you. I am looking at bullet one and the scenario of concern that we partially discussed this morning is a small break LOCA, and the scenario is a LOCA inside containment with or without a successful reactor trip. An ECCS fails and CVCS injection succeeds.

And so the questions are, you know, that we -- the staff received is does the PRA slide 33 from the staff's presentation cover this? Is this -- is it based on a calculation on engineering judgment?

Okay. Now, for these scenarios, for both of these scenarios, CVCS injection is needed to prevent core damage from inventory loss.

When the staff reviewed these scenarios, you know, based on Peter Yarsky's white paper, CVCS injection following an ECCS failure does not cause a reactivity insertion that could cause core damage, based on Dr. Peter Yarsky's mixing discussion that was presented this morning.

Does that answer everybody's question?

MEMBER KIRCHNER: Marie? Marie, this is Walt Kirchner.

In that scenario where ECCS has failed, then the pressure of the system is higher. I don't know exactly when you decide CVCS is injected. But the pressures are higher. Is that true?

MS. POHIDA: It's --

MEMBER KIRCHNER: In other words, you've got a small break LOCA. You're depressurizing the primary. You're losing inventory to the containment. You're on some kind of decay heat curve and you are slowly depressurizing the primary system and losing inventory.

MS. POHIDA: Yes. We are considering that ECCS fails upon a legitimate demand around 900 pounds.

MEMBER KIRCHNER: Yeah. So that's the set point, the nominal set point. Here's the concern that I would raise and ask whether this was looked at.

Peter broke up his analysis of these events into two categories. One he called transient and the other prolonged, and it was the transient -- the quick transients that were the more plausible way of rapidly introducing deborated water into the core.

So if the CVCS system trips and injects colder water, doesn't that rapidly have the effect of either making the riser swell and/or depressurize the system, which would lead to void formation, all of which would then introduce a surge of water into the core?

MR. YARSKY: So, Walt, this is Peter Yarsky from the staff.

We thought about this. If the CVCS injects into the pressurizer, so you turn on pressurizer spray, of course, that can lead to depressurization and flashing and level swell.

But the amount -- like, the pressurizer spray is not going to be as good at depressurizing the vessel as opening the RVVs. So the idea is if the RVV opening case does not result in core damage, then the pressurizer spray case will be bounded by that.

So I hope that that sort of addresses the question with regards to pressurizer spray.

MEMBER KIRCHNER: But the RVD, if I might pursue this, is like a LOCA in and of itself and that's a slower depressurization, isn't it? Or faster?

MR. YARSKY: Well, the choking flow through the RVVs --

MEMBER KIRCHNER: Is it faster?

MR. YARSKY: If you open the RVVs you should -- it's going to be like large break LOCA. You're going to depressurize relatively quickly. So it's going to be more severe than using pressurizer spray.

MEMBER KIRCHNER: And so your argument about the --

[Simultaneous speaking)

MR. YARSKY: -- the RVV opening sequence you don't need to analyze the pressurizer spray sequence because it will be bounded.

So the pressurizer spray can lead to all the phenomena that we are talking about. It just won't be as bad as RVV opening.

So we are not saying it doesn't need to be considered. It's just you don't need a separate calculation. You can just use the RVV opening calculation because it's bounding.

MEMBER KIRCHNER: And what is your assumption at that juncture of -- so you're assuming that the boron concentration or that there hasn't been any significant boron dilution in the downcomer?

MR. YARSKY: Well, if you --

MEMBER KIRCHNER: Because of either the holes or just the --

MR. YARSKY: Yes. So the other thing we considered is, like, yeah, let's say you do somehow, like, get the RVVs open, right, and then you depressurize and so the level drops down and so then you can dilute the downcomer and then you turn on pressurizer spray.

If you turn on pressurizer spray later after RVVs are open, it's going to be kind of like an "oh, never mind" because you're starting from such a low pressure at that point that the level swell effect is going to be really muted.

MEMBER KIRCHNER: Okay.

MR. YARSKY: So we looked at -- RVVs do not open if you turn on pressurizer spray early because you've diagnosed that as ECCS failure. Then the resultant flow incursion is not as severe as would have had occurred if the RVVs opened.

So we just didn't identify it as a different -- as something that needed to be analyzed because it would be bounded.

And then if you looked at, well, maybe ECCS does actually and then somewhere later on you turn on pressurizer spray once you get a level swell, well, yeah, you will. But the pressure is really low so it's going to be mild.

MEMBER KIRCHNER: Thank you.

MR. YARSKY: The other concern is CVCS injection into the riser and that can collapse voids and cause a transient flow incursion and that's something that we did look at.

MEMBER KIRCHNER: Marie, I apologize. I interrupted you. Have you anything further to add?

MS. POHIDA: No, not on the sequence. If I might continue with the second bullet.

MEMBER KIRCHNER: Yes, please.

MS. POHIDA: Thank you.

Okay. The second bullet concerns a CVCS charging line break outside of containment and this is not an ATWS scenario, and the sequence in question is number five and it's a CVCS charging line break outside a containment. There is a successful reactor trip. However, containment isolation fails.

DHRS succeeds and only one train is needed. But now, given the design change, ECCS is now necessary for the operators to inject using CFDS to prevent core damage. And the time -- we are in open session but the time for the operator to inject using the cavity flood and drain system is minutes.

So that scenario is not long enough to cause significant downcomer decoration.

MEMBER DIMITRIJEVIC: What do you mean minutes? Minutes after what?

MS. POHIDA: Let's see.

MEMBER KIRCHNER: Marie, did you hear Vesna's question? It was minutes -- minutes after what. Where are you measuring minutes from?

MS. POHIDA: The minutes after -- I am looking here at my charts, and I am mindful I am in open session so that I am thinking slowly here.

It's -- this is the time after ECCS is demanded and it's -- it's minutes. If specific times are needed, I request to go to a closed session because it is proprietary information.

MEMBER KIRCHNER: Vesna, do you need

specific numbers or just --

MEMBER DIMITRIJEVIC: I not need specific numbers but there is an operator action associated with this.

This is an important scenario because the containment is bypassing the same time. So we are talking about the large releases. So the thing is that here the operator action for this activation of the containment flood is just your usual 40 minutes three, you know, AGP and if this is some action which has to be performed in the minutes that's not described anywhere. So I am not sure are we talking about the same thing.

MS. POHIDA: This action was evaluated in the staff's SER in the Phase IV SER that was finalized in January -- this action. This operator action -- this operator action is classified as risk significant. This action of being able to use CFDS to prevent core damage and it is evaluated in our SER.

MEMBER DIMITRIJEVIC: So is it a human error probability change now for this action, given -- I mean, that will be very high probability of, you know, 0.1 or something which has to be performed in such a short time, and not like 14,000 which is currently.

MS. POHIDA: You know, in terms of the timing chain I am going to have to either defer to NuScale or to provide this information to you -- get back and provide this information to you.

I am looking at the times now. It's just that we are in open session.

MEMBER DIMITRIJEVIC: Okay.

MS. POHIDA: But I would be happy to provide that information to you.

MEMBER DIMITRIJEVIC: Okay.

MS. POHIDA: But the action of defeating the containment isolation logic and using CFDS for injection is described in the PRA and our SER.

Does that help answer your question?

MEMBER KIRCHNER: Vesna --

MEMBER DIMITRIJEVIC: Well, yeah, it does -- it answers partially my question. I mean, you know, the -- this moment I am sort of lowering my expectations.

So I have to think about this. And, actually, I get information from you because now suddenly we have important human actions, which was never identified in the -- in the Chapter 19 and also we have -- we have the different discussed timing for the actions which will really, you know, render the probabilities, however, maybe not to be valid. I have to -- you know, when you give me additional information I have to think about that.

So, basically, your response to this, if I can summarize, if you ever have tripped the CFDS it has to be just minutes after the ECCS.

MS. POHIDA: I think the word minutes is causing confusion. I would like to provide specific times. But I believe that we need to go to closed session.

MEMBER DIMITRIJEVIC: Okay.

MS. POHIDA: But thank you. That -- if there are no other questions, that concludes the two bullets of the ACR's questions that were provided to the staff.

MEMBER KIRCHNER: Marie, could I -- I don't want to push you into a position that you're not comfortable with. This is Walt Kirchner.

MS. POHIDA: Thank you.

MEMBER KIRCHNER: When you say minutes, are we saying less than an hour?

MS. POHIDA: I think I -- you know, either I defer to NuScale or we go to closed session.

MEMBER KIRCHNER: Okay. I don't think I want to call a closed session just for that specific a question. If you could just provide the information to us through Mike Snodderly we would be much obliged.

MS. POHIDA: I would be happy to do that. Thank you.

MEMBER KIRCHNER: Okay. I think we are through with the questions that the committee submitted. Is that correct, Mike Snodderly? I may have --

MR. SNODDERLY: Yeah. I think --

MEMBER KIRCHNER: -- I cut Mike off. I am sorry.

MR. SNODDERLY: That's okay. You know, after Peter corrected me I went back and looked. Yeah, those are the two specific scenarios that Vesna asked be addressed and those have been addressed. And so now I think -- I think NuScale had requested to --

MEMBER KIRCHNER: Yes.

MR. SNODDERLY: -- provide some additional information.

MEMBER KIRCHNER: Okay. So from NuScale are we turning to Mike Melton or -- I'll turn to NuScale to introduce their information.

MR. MELTON: Thank you, all. It's Mike Melton. I was -- just come off mute so I am all good.

Yes, just a little bit of time we'd like to go through some topics, just high level points related to our post-event repair and restart procedure development, a little bit of touch on our capability in intermode 4. We have some comments on reactivity balance and then some conclusions.

So, with that, I'll let John Fields sort of kick us off.

He's our LPM for the topic, introduce our presenters, and then we will read some points after that. So let's go for it and, John, if you're off the mute you can introduce our presenters and get us going.

MR. FIELDS: Good afternoon. This is John Fields. I am licensing project manager with NuScale. Can you hear me okay?

MEMBER KIRCHNER: Yes, John. We hear you. Thank you.

MR. FIELDS: Okay. So I am going to cover the regulatory framework for procedure development, specifically, operator procedure -- operational procedure development from the design certification application up to construction of startup.

In the design certification application, the applicant provides the design of the facility. The procedures are not developed. Rather, a combined operating license item or items documenting procedure development requirements are defined in the DCA.

NuScale complies with this by discussing a procedure development program in DCA Section 13.5. For operations procedures, NuScale COL Item 13.5-2 requires a description of normal operations, abnormal operations, and emergency operations procedures.

COL Item 13.5-5 augments the COL Item 13.5-2 with the requirement that the COL applicant provide a schedule for development and implementation of these procedures.

As it relates to boron redistribution in FSAR Sections 4.3.1.5, 15.0.4, 15.0.5, and 15.0.6, and tech spec basis 3.3 address the potential for boron redistribution to occur during extended passive cooling conditions.

These sections also describe the acceptability of plant design changes (audio interference) to verifying boron concentration and adjusting the concentration if necessary.

At the COL stage, operating and emergency operating procedures are established prior to fuel load. The purpose for this is to, quote, "allow adequate time to develop operator license examinations," end quote, which the NRC will review, and that comes from SRPs 13.5.2.1 and 13.2.1.

Finally, the regulatory framework has modified over time to also include more guidance for the development of strategies for addressing beyond design basis events.

These include regulatory requirements for severe accident management guidelines, extensive damage mitigation guidelines, and most recently, the diverse and flexible coping strategies, or what's known as flex strategies.

So the main takeaway from this discussion is that NuScale is compliant with the regulatory requirements and operations procedures of all types -- normal, abnormal, emergency -- and these guidelines for beyond design basis events will be developed by COL applicants and reviewed by the NRC prior to completion of startup and operation of a NuScale power module.

Are there any questions on that?

MEMBER MARCH-LEUBA: Yes, there are. John, is there -- in that framework you're reading for is there any requirement that the COL applicant provide a safety analysis demonstrating that those procedures are adequate to the (audio interference) Is there any expectation that we --

MR. FIELDS: Certainly, anything -- certainly, anything that departs from the VCA, the approved and codified design requires NRC approval again.

MEMBER MARCH-LEUBA: Right. But the SER said you can -- the operator can do anything they want, and as long as the operator is doing anything they want you're not departing from the CVA and, therefore, would there be any -- would you expect the CVA --

MEMBER KIRCHNER: Jose -- Jose, can I interrupt you? We are on the public record. I don't think the FSER says the operator can do anything he wants or she wants.

We need a little more precision here. Point out the section and the problem you're having. But the FSER does not say what you're interpolating.

MEMBER MARCH-LEUBA: The FSER says there are no possible operator errors of omission or commission that will damage the door in these circumstances.

MEMBER DIMITRIJEVIC: Jose, can you point to the page? I have SER in front of me with the changes. Can you just point -- you said the section was 19.146 and then I didn't write at the time what was the next. So what is the section? Can you point to the page where it says that?

MEMBER MARCH-LEUBA: I would have to look at it. I mean, I don't have it. I moved to a different section. So I will -- I will look at it after I am talking about.

MEMBER DIMITRIJEVIC: All right.

MEMBER MARCH-LEUBA: But, definitely, Vesna, as you are in the form. Can you confirm that the PRA does not include any operator errors of commission --

MEMBER DIMITRIJEVIC: Yes. Yes. That's through -- it states actually explicitly in the PRA that there is no -- identified errors of commission is important and also it states that errors of sabotage are not considered.

MEMBER MARCH-LEUBA: Correct. So there is -- an error of commission means the operator made a mistake and pulled the wrong switch and operated the wrong equipment.

What PRA says is he can pull all the switches in there he wants and he cannot make that error because there is no error of commission. That's what the PRA says. And the SER says, yes, we agree. So at the time the COL applicant developed these procedures, they will develop the procedures.

They will be thorough and careful and they will do the most logical procedures they can find. But I don't see any requirement that they will have to do safety analysis to go beyond the hand waving that we have seen today. That's what I see.

MEMBER KIRCHNER: Marie, would you like to interject a comment. I see you've unmuted your mic.

MS. POHIDA: No, I didn't have a specific comment. If there's a question addressed to me, can it be restated, please?

MEMBER KIRCHNER: No. No, there wasn't a question. There was a statement made by a member of the committee. I just saw that you popped up on my screen. I thought you wanted to make a comment. It's okay.

MR. FIELDS: If there are no further questions, I'll turn it over to Ben Bristol to talk about our design capabilities.

MEMBER MARCH-LEUBA: Ben, hold on a minute. I need to give a number to Vesna. The new section is 19.1.4.6.4 and it's on page 19-33 of the compare -- version 4 versus 6 compare of Chapter 19.

MEMBER DIMITRIJEVIC: All right. Thanks. The page in point, 19.33?

MEMBER MARCH-LEUBA: Yeah. Page 19-33, but this is the version of it that has track changes. So it might be different from --

MEMBER DIMITRIJEVIC: I have the same version with the track changes and it's a good section. So that must be the paragraph in the end of it right? That's where it states the commission thing? Okay. Thanks. I will just read it now.

MEMBER MARCH-LEUBA: The one I am more opposed to is when it says -- in the next to the last paragraph. It says, "Therefore, the staff finds, dot, dot, dot, that the misoperation of CFES, dot, dot, dot, is not a significant risk contributor."

Okay. Unless you have more questions, Vesna, then you can go ahead and continue

MEMBER KIRCHNER: But, Jose, just for the record, I can't let this go. That doesn't -- that doesn't equal that the FSER says the operator can do anything he or she wants.

MEMBER MARCH-LEUBA: It is different. It's a different paragraph. This is the one in the CFES.

MEMBER KIRCHNER: I am just making this statement for the record.

MEMBER MARCH-LEUBA: There's a different

section that says there are no operator errors of commission that are considered in the PRA.

MEMBER KIRCHNER: That may be accurate. They didn't consider them. That doesn't say the FSER says the operator can do anything he or she wants. I am just objecting to your interpolation of what you're reading on the public record.

MEMBER RICCARDELLA: For the record, it's extrapolation, not interpolation.

MEMBER KIRCHNER: Thank you, Pete.

[Laughter.]

MEMBER KIRCHNER: Okay. Let's go to Ben Bristol, please.

Ben, good afternoon.

MR. BRISTOL: Yes, good afternoon. So I am here to cover for a little bit of the system capabilities from the plant perspective.

As Ryan covered, I thought, pretty well this morning the scope of Chapter 15, which is mostly my area, leaves us with a deterministic analysis of the design basis event and in them -- in quotes, "safe and stable condition" and I want to put on the record, NuScale believes that boron accumulation in the core is very beneficial.

That's a function of the ECCS design, and that enhances the -- or reduces the likelihood of stuck rod return to power consideration. So we do not believe the characterization of the degraded condition is actually true.

The importance of the boron is where it is relative to the core now. That does mean that boron is transported from containment and, potentially, is a downcomer as discussed quite a bit over the last several weeks, and as part of that process.

So one result is careful consideration needs to be taken in terms of reestablishment of the levels in the containment and in the RCS that are consistent with most boron.

We recognize that an event will not result in a restart and require repairs and those are of, I think, specific interest in this particular conversation.

So in terms of the recovery actions from the potential LOCA events where we, potentially, disabled the CVCS and the ability to inject, I think we have discussed why injection over the core and recirculation through the downcomer with letdown allows -- excuse me, allows us to actually monitor what the boron concentration is in the system.

I think one of the -- the two primary

considerations that I'd like the members to consider is that, one, boron addition can be performed in a batch mode, right.

So we can -- we can inject, based on procedure, a specific amount, wait and monitor the conditions. I thought Peter did a good job explaining that the neutron monitoring system does have the capability of evaluating gross reactivity changes. So operators are not completely blind with respect to where we are in terms of criticality.

So I think that's the -- the first point is that systems don't just -- don't have to be turned on and left on, right. We can -- we can inject certain amounts -- specific amounts of borated liquid.

The other real important consideration is that the coolant addition is always colder than the RCS temperature conditions. The boron addition system is maintained at approximately full temperatures, sort of in the 100 -- the 50 to 100 degree range depending on environmental conditions and what the plant is, and that will -- that will always ensure that whether we are injecting into the riser or the downcomer that will preferentially mix and that if mixing doesn't occur that the boron will -- the borated water will settle toward the bottom of the RCS and not present a stratified manometer injection type phenomena.

MEMBER MARCH-LEUBA: Ben?

MR. BRISTOL: So the third thing I --

MEMBER MARCH-LEUBA: But a couple of things. First, I interrupted you. Let me go to the previous one. You meant -- you said that increasing the boron concentration in the core is beneficial for the stacked rod return to power.

I am glad you think so, but this is an end of cycle condition where your ppm is 10 ppm. If the boron concentration goes from 10 ppm to 20 and, therefore, is irrelevant to the stacked rod condition -- I mean, it's beneficial. It's not that -- let's say it's not detrimental, but saying it's beneficial is a little bit of an overstatement.

Second, what would the -- what is the temperature of the downcomer? The downcomer is connected through the wall of the containment through the UHS pool and this -- it's been there for 72 hours. It's not done much hotter than the UHS.

What is the temperature of the downcomer fluid at 72 hours? Because you're taking credit for it being hotter than the injected CFDS liquid which, by the way, was in the containment, not the downcomer.

So, if anything, it would fall down at the bottom of the containment it was so cold. So and that's why I keep saying that one thing is moving your hands and saying things look my way. Another thing is doing a full analysis.

Keep going.

MR. BRISTOL: Sure. So and what I am attempting to do is provide some basic physical arguments, and I'll get into the relevance of temperature after this next point.

With respect to the CFDS, and I am glad you brought that up, the containment flood drain system has a very important feature, which is we can actually drain the containment.

So in the event that we have the ECCS cooling conditions for a period of time and do not necessarily know what the containment boron concentration is, we can actually drain the containment prior to refilling it with cool concentration, which definitely -- which ensures that operators have a possible procedure that could be followed where without having to measure the concentration we would know exactly what the core concentration is if we were to relate the containment concentration is if we were trying to reestablish levels through CFDS alone.

So I think in terms of walking through a couple of the scenarios, if we had a discharge line failure as a consideration then we wouldn't necessarily have the ability to sample the downcomer concentration.

But we do have injection capabilities. So if operators were able to diagnose the discharge line failure was the event initiator, a potential procedure could look something like draining the containment, refilling it with -- and after the containment is drained injecting to the core and that will push the downcomer water back into the containment, at which point it can be sampled and that process can be repeated in a batch mode until we actually know what the concentration is in the downcomer because we have the ability to measure it.

In the case of an injection line failure -- I think this is one that we have spent some time talking about -- pressurizer spray can be aligned and I would remind the committee that the pressurizer baffel plate has eight holes that are uniformly distributed around the radius of the vessel.

So through the containment spray we can actually inject borated water into the downcomer directly, spilling over the generator tubes and I think that's where the importance of the temperature, the injected temperature, is relevant.

If we are injecting in the downcomer we want to ensure that it mixes, right, because we don't want a stratified layer entering the core, necessarily.

Obviously, once the level is increased then we can pull off of the discharge line and sample what the concentration is, and because the core is in a cooled state there is no time pressure for this and we can monitor it, like we said, with the NMS.

And I think, finally, the final consideration there is for some reason CVCS is completely unavailable. We can drain the containment, refill it with cool water, which will be colder, and that will ensure that the recirculation water through the reactor recirc valves is colder than the downcomer and will preferentially mix and, again, that procedure, if we were to do it, would be handled very slowly and be monitored carefully because that's the one where mixing would be -- would need to be ensured in terms of ensuring that we weren't having an inadvertent reactivity excursion.

So just a quick summary of what we covered. The slow controlled injection of colder borated water directly into the downcomer can be engineered in the event of the loss of the ability to inject above the core to ensure that recovery actions can establish the module back into the normal operating state without risk of an inadvertent criticality.

MEMBER MARCH-LEUBA: Okay. So this is fantastic. This is really good, man. I mean, finally, through my unrelenting efforts, you guys finally have spent a couple of days trying to think how this would be done.

I can find a lot of problems, like I found with your stacked rod return to power. This is something that should probably be reviewed aggressively.

For example, how does the containment-draining system work? Doesn't it work by producing --

MR. BRISTOL: So the specifics there are we would use the containment evacuation system to pressurize probably with nitrogen or some noncondensable. Both ECCSes actually at this point.

Once the system is pressurized to some -- to some point -- I don't know the exact specifics of atmospheric conditions -- then the drain line can be opened up and we can pull the liquid out the bottom of the containment vessel.

MEMBER MARCH-LEUBA: So you would pressurize the top of the containment to push the water out?

MR. BRISTOL: Correct.

MEMBER MARCH-LEUBA: And what effect would that have on downcomer and riser?

See, that is the type of thing that one has to work through and actually simulate. Let a computer calculate it and see if it's good or bad. Certainly, depressurizing would be really bad.

VICE CHAIR REMPE: How long does such a process take, just roughly? A day? An hour? Two days?

MR. BRISTOL: I think -- I think the process -- I think the key point from NuScale at this point is that because we have the inventory and established cooling in the core and, you know, just passive decay heat removal, these procedures would be event specific and they would be planned out.

We have a couple of statements regarding that coming up here in a few minutes. But I think for the purposes of the discussion today, I think NuScale heard some of the conversation about, you know, the system capabilities and I was -- I am not really here to get into the specifics of exactly what the procedure would be.

But we do have -- with the systems that we have in the plant, we do have a variety of ways that we could recover in the unlikely event that something happened to CVCS.

MEMBER KIRCHNER: Ben, this is Walt Kirchner. Just a question of clarification. When you say inject in the downcomer, you're really saying inject into the pressurizer and drain into the downcomer, correct? You can't use the letdown line as an injection point. Or can you?

MR. BRISTOL: Yeah, that's -- so the pressurizer spray line is lined up on the injection side.

If we had an injection line break inside containment we could line the pressurizer spray up with the bypass valve and then -- yes, exactly like you said, we can add coolant to the pressurizer and let it drain down into the downcomer.

MEMBER KIRCHNER: And the holes for the control rod guide tubes in the baffel plate, those are -- that's a relatively tight fit so that there's no preferential draining into the riser? It's preferential draining into the downcomer?

MR. BRISTOL: Correct.

MEMBER KIRCHNER: Okay. Thank you.

MEMBER MARCH-LEUBA: Ben, if you had to because both pressurizer line and the transient line didn't work, and you just have access to the downcomer line, you could revolve your CVCS or, worst case scenario, get a plumber with a welding torch and put the new pump -- and put boron through it? You could, right? If you had to.

MR. BRISTOL: Certainly, and I think there are examples in industry under severe accident conditions where there's quite a bit of creativity that is applied to ensure, you know, the movement of materials after an accident.

MEMBER MARCH-LEUBA: We have had this argument internally. What I am saying is if you have to -- that would not be your preferred option but if you had to, you could use that?

MEMBER KIRCHNER: Yeah, but the existing -- you know, sticking with the DCA, the existing plumbing layout for CVCS does not provide for that contingency.

I mean, do you see what I am asking, Ben? I just want to -- that was my question of clarification. There's no way with the existing CVCS system as laid out in the DCA in Chapter 9 that you would be able to inject through the letdown line. That's a one directional line. Isn't that correct?

MR. BRISTOL: Yes, I believe there's a check valve along the way.

MEMBER KIRCHNER: There's a check valve, yes.

MR. BRISTOL: But certainly if we were getting creative then, you know, we would figure out --

MEMBER KIRCHNER: I know, but, I mean --

MR. BRISTOL: -- a way.

MEMBER KIRCHNER: Cutting plumbing and so on, I don't think is in the scope of a DCA review.

MR. BRISTOL: Thank you, sir.

MEMBER MARCH-LEUBA: So with a view of what I've been trying to say all along, this was very good. Finally you guys thought about what possible things you could do.

Don't you think that was worth -- maybe not in there per se. Maybe it's a white paper submitted during an audit to allow this stuff to see in an audit.

MR. BRISTOL: So I think that question is directed to me. I would say at this point, I mean, NuScale is certainly committed from a business perspective to support customers well beyond just this one licensing activity. So it is important to us obviously to ensure that we have the technical capacity to understand these problems and these challenges and support future licensing endeavors.

But I think we absolutely discussed a fair amount the specific that the specifics of these procedures fit within the framework of the design phase that we're within. But we do have capacity within the systems to develop creative processes to ensure that safety is always ensured and is a top priority.

MEMBER MARCH-LEUBA: And may I assume that your final COL PRA would then include operator errors of commission if the sophisticated, complex recovery procedures are not followed perfectly? And you can see a new world, Mike, when my computer tells me my device has poor operator quality. I'll --

MR. MELTON: Yes. This is Mike Melton, manager for licensing. At this point, I'd like us to not make any speculation on that and let our next slide presenter proceed.

MEMBER KIRCHNER: Go ahead, Mike.

MR. MELTON: Thank you, sir. That would

be Mr. Ross.

MR. SNUGGERUD: Can you guys hear me?

MEMBER KIRCHNER: Ross, you're just a little muffled, just speak up or more closely to your mic.

MR. SNUGGERUD: Yes, sir. Is this better?

MR. MELTON: There you go.

MEMBER KIRCHNER: Yes, that's better.

MR. SNUGGERUD: Thank you. All right. Well, I appreciate the time and chance to speak. My name is Ross Snuggerud. I'm the Chief Engineer for Operations.

And I just have kind of a summary statement on NuScale's position regarding the state of the reactor after accidents. And I'd like to read through it. It's less than half a page. And then I'll take any appropriate questions after that.

It is recognized as a result of the work performed by NuScale and the review provided by the NRC staff that the operation of passive safety systems in a NuScale power module provide an extraordinary level of protection to the reactor fuel.

These systems prevent fuel damage over a large range of accident conditions. The NuScale plant provides this level of protection for an extended period of time without the need for additional water, a source of power or operator actions.

It is also recognized that when these passive systems are used, a re-distribution of boron within this module may occur. As a result, restoration actions must consider these conditions and ensure that work done to place the module in a condition that supports entry into Mode 4 is done safely.

The flow path available to operators and the instrumentation provided with the module provides sufficient means to support the owner in taking these steps.

NuScale can support the owner, the COL applicant, in developing procedures that implement actions to return the facility to normal operation where the impact of the event and the status of plant equipment can be anticipated, for example, in a loss of feed water event.

These procedures will have entry conditions that ensure the plant conditions are consistent with assumptions made during the development of the restoration process.

But consistent with industry practice, these procedures will not address all potential restoration scenarios from all potential accident conditions.

It is likely that the procedures needed for restoration from scenarios like those discussed by the ACRS last week and this will be developed after the event with the oversight of the NRC.

These restoration procedures will take into account current plant conditions, available instrumentation, existing water levels, required boron concentrations, appropriate flow rates or batch volumes and any other factors that impact safe restoration of the power module.

The advantage of the NuScale design, in contrast to those facilities currently operating in the industry is that while these actions are being planned, the module will remain safe without the need or support of any active safety systems.

It is NuScale's position supported by the staff's review that there is ample margin for restoration actions to be performed safely.

MEMBER KIRCHNER: Is that it, Ross?

MR. SNUGGERUD: Yes. That's the end of my prepared statement.

MEMBER KIRCHNER: Okay. Thank you. Just a question of clarification. You have used a term just a little bit different than we've been talking about. We've generally been talking about recovery from these design basis events. And you're talking about restoration.

Is the implication of that word that you're out in a longer time period and actually doing interacting --

(Simultaneous speaking.)

MR. SNUGGERUD: No. The choice is intentional because we feel like recovery implies that the state that you're currently in is unstable or unsafe. And we don't believe that's true.

So as an operator, and the way the emergency operating procedures will be developed, we're going to be monitoring critical safety functions. And when those critical safety functions are met, we're in a position where we're not going to take any actions that we aren't positive will result in an improvement of the situation.

So if your safety functions are met, which they are in Chapter 15 for us by design, then as an operator you're not in any hurry to do anything until you're sure the action you're going to take is going to improve the condition of the reactor.

So we chose to call that restoration just because we thought that there was some connotation associated with recovery, but functionally we're probably talking about the same thing.

MEMBER KIRCHNER: Okay. Thank you very much. Yes.

MEMBER MARCH-LEUBA: Hey, can I ask you a question? I've been measuring always a transfer to Mode 4 because that's when you have to do the restoration so you can move the module to the computer station.

But the moment you lose CVCS, for example, or I suspect in most situations, you will A, start de-borating the cover, B, you would likely lose your boron measurements limitation. But you will also drop below 420 degrees Fahrenheit. So you will go from Mode 2 to Mode 3 on temperature.

And the operator will either measure whether the water concentration is too low and inconsistent with Mode 3 or will be incapable of misreading it, which will put you in an LCO.

What would an operator do when he's an LCO that says that he cannot determine what the bottom concentration is?

MR. SNUGGERUD: So the LCO is applied to pre-accident conditions. The reason for the LCOs is to ensure the reactor, prior to an accident, is within the design basis of the calculations.

So it's understood that should you experience an accident, you will find yourself in a condition that doesn't match your LCO conditions. Part of the reason for calling the procedures restoration procedures is you're going to start the process of putting the plant back to within the tech specs so that you can continue forward on recovery and return to service or maintenance or those types of things.

And we believe for the vast majority of the types of scenarios that we're talking about when we are operating for a long period on passive cooling that the systems and components available to the module will be sufficient to support doing that.

It may take a while. We may choose to do small batches and wait. It could take suction. And we may even have to use separate equipment if there has been damage to the module that wasn't anticipated.

But in all cases before you can transition into Mode 4 and before you can pick the module up, you're going to have to re-establish boron concentrations within the Mode 4 capabilities or you're going to be asking for special permission from the staff if there's some reason why you couldn't do that and you wanted to proceed to the refueling area.

And in that case you're going to be explaining to the staff why that's a safer option than finding a way to meet the requirements.

MEMBER MARCH-LEUBA: So you're saying that under these safe and stable conditions with ECCS operation, you don't have to satisfy the tech specs mostly?

MR. SNUGGERUD: You're not in the LCO action if you've had an event.

MEMBER MARCH-LEUBA: Okay. Let's not argue about it. But some of these situations are purposely performing, for example, when you went into refueling. But let's ignore that.

MR. SNUGGERUD: I don't disagree with you. The goal of the operating staff is going to be to get the module to Mode 4. But there's no hurry. There's no emphasis on trying to do that at any kind of speed. It's going to be done when it can be done safely.

If there aren't any other questions, we have another presentation by Etienne looking at the reactivity balance.

MEMBER BLEY: This is Dennis Bley. I have to sneak in one word. I hear a lot of hair splitting about how operators will behave often by people who are analysts and engineers and very good ones at that but not operators.

Operators respond to the current situation to their training, especially the most recent training. This particular scenario is in the range that probably won't be trained on a lot.

But when operators get in a spot, things pop in their heads, and they sometimes respond. We'll get to the procedures eventually. But the optimism isn't always well-placed, and there's a whole world of operating experience examples by which we can show you that.

MR. SNUGGERUD: Yes. And I understand your point. But I was a licensed senior reactor operator for 10 years. And I helped put the training program together for our ISV program at NuScale. And one of the things about the NuScale design that is unique is if the containment isolation valves work as designed, the public is safe.

And the only way as an operator that you're going to put the public at risk is to open one of those valves. So in our procedures when we did the training and when we did the scenario that involved the beyond design-based accidents that required operators to open containment, you know, we put special things into the training. We put special things into the procedure.

Again, all of those things are emblematic of what we expect an operating plant to do, but the nature of trying to operate 12 reactors, understanding what your safe conditions are and what your unsafe conditions are, operators are very much trained these days to not take actions when unsure.

And the one they're going to be sure of is if the containment isolation valves are closed, the public is protected. So I do think it's reasonable to assume that those operators are not going to be taking any actions in any kind of swift, unprepared manner that are not in accordance with written procedures to upset a module that is in a safe condition.

MEMBER BLEY: I admire your confidence. Go ahead.

MR. SNUGGERUD: I appreciate your skepticism, and I understand it.

MEMBER DIMITRIJEVIC: Can I add something on the containment? Because there is a two LOCA switch outside the containment, you know, charging line and (audio interference) which are -- so there are two events in this case, which lead directly to unisolated containment.

MR. SNUGGERUD: And I tried to reference those, and I agree with you. And in those cases, I would argue that your containment isolation has failed.

And in those cases we have demonstrated and developed procedures that show how a COL applicant could train their operators to address those beyond design basis accidents that involve containment bypass.

And when we did that, we made a big deal. There's special alarms in the control room, in our emblematic control room, and there was special actions that the crew had to take. Everybody on the crew had to agree that opening containment was the correct action.

Again, that's NuScale performing ISV to support our staffing plan and to support the people who were doing the human factors engineering evaluation. But that's the same kind of logic and training we are going to offer any COL applicant that is interested in a NuScale plant. And they should be interested in getting it from us since we put so much effort into developing it.

MEMBER MARCH-LEUBA: Hey, did you train

your operators to respond to a failed CVCS injection line LOCA? Did you ever run that LOCA with it?

MR. SNUGGERUD: So I don't -- well, I know we ran that LOCA. I don't know -- I don't remember --

MEMBER MARCH-LEUBA: How do you recall --

MR. SNUGGERUD: -- running that LOCA during ISV. We didn't do recovery.

MEMBER MARCH-LEUBA: Sorry, excuse me, restart.

MR. SNUGGERUD: We didn't do restart of that unit. We got it to the safe, stable condition and left it at that position.

MEMBER MARCH-LEUBA: Two months ago, how would you have restored?

MR. SNUGGERUD: How would we have restored?

MEMBER MARCH-LEUBA: You have to recede a VS before draining containment.

MR. SNUGGERUD: We don't have an operator. Sorry.

MEMBER MARCH-LEUBA: Yes. Okay. It was rhetorical.

MR. SNUGGERUD: And I understand that. But my point, the way these would be addressed is you would sit down, look at the conditions that caused you to be in the situation that restoration was necessary and evaluate your options, put together a plan, vet that plan with engineering, take it to your site's safety analysis review group, take it to your site's overall safety -- I mean, there's lots of things that would happen.

NuScale is the design organization not the operating organization. But the operating group within NuScale would expect that situation to be handled the same way that all post-LOCA situations are handled in existing plans. There are not procedures for post-LOCA.

You know, if I had been on ECCS and containment spray and I had emptied my SER W tank and I'm on recert from the sump, there isn't a procedure for how you get out of that. What you do is you assess the things that you're ready for.

MEMBER MARCH-LEUBA: So if you have a -- one moment. I'm moving my phone. You go ahead. I'm sorry. You don't want to hear that.

MR. SNUGGERUD: So, you know, again we're talking about things that the COL applicant is going to deal with. NuScale is confident that there is equipment available in a safe place to restore a plant from all of these conditions where a path to cooling has an operating for a long time.

There are ways that are better than others. And we will be there to support the owner if and when that becomes necessary. But, you know, I'm talking in circles at this point, and I'd like to pass it off to Etienne.

MEMBER KIRCHNER: Okay. Let's transition to Etienne, who is, I believe your PRA person. Etienne, can you hear me?

MR. MULLIN: Yes, I can hear you. Can you hear me?

MEMBER KIRCHNER: Go ahead, please. May I ask other people to turn off their mics because we're getting feedback in the system.

MEMBER BROWN: Walt, are there slides or is this just talk?

MEMBER KIRCHNER: I don't know. Etienne?

MEMBER BROWN: I haven't seen any slides for the last four or five people.

MEMBER KIRCHNER: I think basically we have oral presentations, Charlie.

MEMBER BROWN: I just wanted to confirm that I wasn't missing anything. Thank you.

MR. MULLIN: So this discussion is going to be a little bit of a step back with respect to talking about the potential consequences of a somewhat adverse operator action, the one that you were talking most about, which is just the operator injecting CFDS, turning it on and forgetting about it, which I think as we've discussed clearly is not what would be the recommended course of action and would likely be violating procedure.

And I want to be clear that it is NuScale's position, and it is supported by the staff, and we've discussed this to a large extent today, that at the loop front moving through the core in this scenario and ultimately encompassing the whole core is physically unreasonable.

However in postulating this scenario, I wanted to make some comments about the conditions in the core that would balance the reactivity insertion from completely de-borating it.

It was described in a meeting two weeks ago in a letter provided to NuScale, and I believe the staff in advance of that meeting, that there are no feedbacks physically possible that could compensate for the potential reactivity insertion from completely de-borating the core.

And I wanted to describe that that is not the case. And we can even go through a very simple exercise of evaluating the reactivity balance under these scenarios using publicly available information in the FSAR, specifically Table 4.3-4. I don't know if you all have that available or if that was provided in advance of this meeting.

MEMBER MARCH-LEUBA: I can find it. I'm looking for it now.

MEMBER KIRCHNER: Go ahead, Etienne. We can always check that. We can pull up the FSAR.

MR. MULLIN: So it's a relatively simple calculation and unfortunately I don't have it listed in front of you so you'll have to bear with me as we walk through it verbally.

But the first thing you have to calculate is the potential reactivity insertion from completely de-borating the core at the beginning of cycle conditions.

Dr. March-Leuba this morning described a 10 PCM per PPM boron width coefficient so we can use that for the purposes of this. And starting with a beginning of cycle boron concentration of 1,235 PPM or so that gives us 12,000 to 12,500 PCM of positive reactivity insertion.

Now I will note just for context that that is on its own less than the control rod worth here, which is 14,414 PCM. And that's just for, I guess, a piece of reference.

Now at the beginning of cycle, according to this table, our net margin to critical in long-term shut down is 5,099 PCM. So the difference between that is the reactivity that would have to compensated for the thermohydraulic conditions or fuel temperature or all these other reactivity feedbacks.

So that leaves us about 7,300 PCM or so that needs to be compensated for by some sort of a feedback if we were to assume a completely de-borated core.

MEMBER MARCH-LEUBA: Can you specify what temperature you propound to state?

MR. MULLIN: This is -- in long-term shutdown we're looking at I think 70 degrees Fahrenheit conditions at core.

So I think the best way to do this calculation using the information that's available to us right in front of us is to use the moderator cooling PCM value here under Table 2C.

Now this value provides the integrated moderator reactivity feedback between shutdown conditions and hot operating conditions. So between 70 degrees Fahrenheit and 545 degrees Fahrenheit.

For reference, importantly, the coolant density difference between these two conditions is approximately 25 percent. So to get the moderator density coefficient or moderator void coefficient for the totally de-borated core, it's most useful to look at the end of cycle value in this table.

And that's equivalent to the moderator cooling value you'll get when there's no boron in the water, which will be greater than when there is boron in the water. And you can see between cold shutdown and hot operating conditions, that's 5,886 PCM. So that's almost all that we need.

So you could extrapolate or interpret this as approximately a 25 percent void fraction would get you mostly to a balanced reactivity. And you can extrapolate from 25 percent up to approximately 30 percent to get you to 7,300 PCM you need to balance the reactivity.

So in summary, this very simplified calculation. It demonstrates that you can get to a balance reactivity with approximately 30 percent or less void in the core and that's 0 credit for boron, of course, 0 credit for xenon, 0 credit for fuel temperature or power defect and actually 0 credit for moderator temperature. We're just crediting moderator void.

So the purpose of that was just to show -- and this is kind of an abstract scenario and quite physically unreasonable to get to these large void fractions and not have an extreme amount of mixing. But it just demonstrates that it's not so much reactivity insertion that you have to assume that the core will be melted.

MEMBER MARCH-LEUBA: So, Etienne, can you point me to the section in the FSAR or a supporting document where this calculation was performed before we raised the question?

MR. MULLIN: No, it's not in the FSAR.

MEMBER MARCH-LEUBA: Okay. So because I raised it, you finally did the calculation. But you have done it in your head, and you knew it was possibly a problem, right?

MR. MULLIN: Sorry. What? I couldn't hear you. I knew it couldn't possibly be a problem?

MEMBER MARCH-LEUBA: Sorry. It's a rhetoric, satirical question. Okay. What I'm complaining about is the lack of scientific rigor in this analysis. You need to seek out these problems by yourself before you submit it to the staff for review because what I'm thinking right here is things that

Jose was hearing you and then he forced you to do the calculation, maybe they're okay. Let's just say you're okay. What else did they miss? They didn't think of this. They didn't do this calculation. They just ignored it. And that's --

MR. MULLIN: I don't believe a fully de-borated BOC core is physically reasonable. That's why this calculation was not included in the FSAR.

MEMBER MARCH-LEUBA: Well, our calculation -- you do calculations from RAI 80930 show at least 15 cubic meters of fully de-borated peak width in an out cover. And an additional, I don't know, 5, 6 cubic meters in there above that are being in containment.

That's what your calculations show. And it might be that certainly now that we have thought about it, we want to develop procedures, complex procedures, in which you have a probability of failure by the operator, that that will make sure this does not happen. But we've got to raise the question. Okay. That was a rhetorical thing. Yes, you keep going. You did okay job.

MR. MULLIN: That's all I wanted to talk about. Thank you.

MEMBER KIRCHNER: Thank you, Etienne.

MR. MELTON: So, Walter, this is Mike

Melton. We're wrapping up our discussion points --

MEMBER KIRCHNER: Thank you.

MR. MELTON: -- the last few points to close out. First of all, the staff review has been at the highest level of detail. And they have pushed us and actually challenged us in a number of areas. So through that we have continued to challenge our own design.

Overall, NuScale is highly committed to plant safety and providing a passively safe design. The NuScale design is capable of safely returning the nuclear power module to servicing all design basis and end state possibilities described in the FSAR. And we believe that is adequately described through a ton of discussions and work as we responded to the NRC questions.

NuScale's policies and procedures govern design and engineering activities with safety as its primary objective. And I think as Ross clearly stated, that is our ultimate objective as we go through the licensing phases.

So, Walt, Mr. Chairman, we appreciate the time to make additional clarification points during this session.

So I turn it back. We are concluded.

MEMBER KIRCHNER: Thank you, Mike Melton --

MEMBER REMPE: Walt?

MEMBER KIRCHNER: -- and NuScale. Members of the Committee, any further questions?

MEMBER REMPE: Walt?

MEMBER KIRCHNER: Yes, I hear someone calling.

MEMBER REMPE: This is Joy. I was wondering, Ben Bristol had some interesting suggestions of what could be done. And I think it would -- I'm guessing he just didn't come with this off the top of his head. He has a write-up.

Would he be willing to send that write-up to Mike Snodderly so he could share it with us to assist us so we don't misquote anything because we won't have the transcript as we prepare our letter? Would that be of help?

MR. MELTON: Yes. This is Mike Melton with NuScale. If there's a request, we would have to run that through Mr. Snodderly and go from there. We can't make any statements at this point.

MEMBER REMPE: Sure.

MR. SNODDERLY: So as long as NuScale realizes that whatever you submit to us, this is an open transcript, and it will be added as part of the record of the transcript and be publicly available.

MEMBER REMPE: And it would be anyhow. I'm just asking if we could have it a bit earlier than before the transcript is processed.

MR. SNODDERLY: I'm just making sure Mike understands that, you know, if he does submit it to us for me to share it, you know, it would become part of the record and it would be added to this transcript.

MR. MELTON: Right. I understand that. I will get with the staff and go from there.

MR. SNODDERLY: Thank you.

MEMBER REMPE: Thank you.

MEMBER KIRCHNER: Yes. Thank you, Mike. Members, before we transition one more time back to the staff for, in fairness, any comments from them and turn to the public, any specific questions on what you just heard from NuScale?

Okay. With that, Mr. Chairman, I think we will now turn back to the staff just to provide them an opportunity to make any further comments if they wish to.

So I'm not sure who to turn to, Bruce Bavol or Anna Bradford, any further comments, or Michael Dudek, that you wish to make at this point?

MR. BAVOL: This is Bruce Bavol, project manager. If the staff doesn't have any further questions, I appreciate the time this afternoon that we were able to provide input. That's all we have.

MEMBER KIRCHNER: We appreciate what you provided. Thank you and thank your colleagues. Thank you very much.

MR. DUDEK: So this is Michael Dudek. I echo Bruce's sentiments. I would like to make one minor clarification at the end.

The staff does now have an NLO from ODC on Chapters 15, 6 and 19. We did not have those NLOs during the earlier meeting in July. And I promised to tie back to the Committee on when we got those.

The only things that were noted in those from OGC were editorial updates. No technical content was changed.

MEMBER KIRCHNER: Michael, for the record, would you tell the public what an NLO is.

MR. DUDEK: No legal objection. It is the standard to which OGC reviews and approves the SERs.

MEMBER KIRCHNER: Thank you, Michael. Okay. Thanks to all the people who participated. I think, Mr. Chairman, we should turn to any public comment and then we'll turn to our colleagues, I think, for any comments they want to make.

I just want to note that once we transition from this part of our program, we will go off the record, the public record and the transcript, and we will be deliberating as a committee.

And at that juncture then, any interactions with the applicant and the staff will be more in the vein of asking for clarification and such but not active debate and participation in our letter preparation.

So this is a good juncture for any comments or any input. Otherwise, I think we now could turn to the public.

CHAIR SUNSERI: Right. Well, and, you know, let's make sure that we invited the people that are on the Skype line as part of this public input, too. So kind of do it in two steps like we would do in a meeting room.

Anybody in the virtual meeting room care to make a public comment? Now would be your time. While we're opening up the phone, we'll address the external. So is the external being opened up, external phone line? Can anybody hear me?

PARTICIPANT: Yes, the external phone line is open.

CHAIR SUNSERI: Okay. So are there any members of the public listening in that would care to make a statement or comment at this point in time, state your name and provide your comment.

MS. FIELDS: Yes, yes. My name is Sarah Fields. I'm with an organization called Uranium Watch. And I've been following the DCA process and the ACRS meetings for quite some time.

I'm going to go back to the very beginning of the day. And I am flabbergasted and very concerned about the sudden inclusion of a standard design approval approval within the context of the DCA process.

I believe that this proposal by NuScale and NRC staff is misleading, dishonest and inappropriate. It does not reflect well on the NRC and the openness of the DCA process.

The public was never informed of any sort of inclusion or reference to the DCA in this design certification process.

The July 13 NuScale request with standard design approval based on the NuScale standards plan design certification application was not made publicly available until earl this morning, less than hour before the meeting. It was not on the ACRS agenda.

The letter states NuScale also requests that the Advisory Committee on Reactor Safeguards consider the same docketed and reviewed information as a basis for issuing a report pursuant to 10 CFR 50.53, which would be the standard design certification and 10 CFR 52.141, which are the requirements for the standard design approval. And that's for the NuScale DCA and SDA, respectively.

NuScale refers to docketed and reviewed information, but there's no docketed and reviewed application related to the SDA, and there are a number of issues that will be included in the SDA.

With the ACRS, there's really no information about, and the public has no information about, for example, NuScale intends to achieve a 25 percent power uprate. I have no idea how they're going to carry that out. But I feel that it's very important. I know the ACRS and the NRC think that it's important.

I think the ACRS and the NRC staff should actually read the regulation at Part 52, Subpart E, Standard Design Approvals.

In Section 52.141, referral to the HERS, which states the condition shall refer a copy of the application to the ACRS. The ACRS shall report on those portions of the application which concern safety.

NuScale and the NRC above indicated that the NuScale SDA application will not be submitted until the fourth quarter of 2021. Therefore, the Commission is unable to refer a copy of the application to the ACRS when the ACRS cannot report on any aspect of the SDA application.

It's not appropriate for the NRC to ask for any type of ACRS approval before the application is then received and reviewed by the ACRS.

The ACRS and NRC would not be compliant with Part 52, Subpart E, if the ACRS issued the DCA report that included any reference to the SDA.

I feel these regulations have force and effect, and the NRC and the ACRS should not ignore them. Also Ms. Bradford said that the staff approval of the SDA application only involved the sending of a letter. That's not quite accurate.

The regulation states upon the completion of its review of a submittal under this subpart, that's Subpart B, and receipt of a report by the Advisory Committee on Reactor Safeguards under 52.141 of the subpart, the NRC staff shall publish a determination in the Federal Register as to whether or not the design is acceptable subject to appropriate terms and conditions and seek an analysis of the design in the form of a report available on the NRC website.

And there's also some good information in the regulation about the finality of the standard line approval. In the discussion this morning, the NRC gave the impression that the SDA was kind of fluid, and things could change during an application process.

But 52.145 says an approved design must be used and relied upon by the NRC staff and the ACRS in their review of any individual facility license application that incorporates by reference a standard design approved in accordance with this paragraph unless there exists significant new information.

This substantially affects the earlier determination for other good cause. In sum, I don't think it's legal for the ACRS to make any reference to some possible future SDA application as part of its final report on the standard design and as part of a rulemaking. Thank you.

CHAIR SUNSERI: Okay. Thank you for the comment. Any other public members care to make a comment? So no others?

It's not normally our process to respond to public comments, but for the sake of transparency, I think it's appropriate to say that the SDA has been brought before the Committee this week --

MEMBER KIRCHNER: Matthew, stop for a moment. Someone has to mute their mic. They're interfering with the audio.

CHAIR SUNSERI: Okay. I can hear it from my side. It sounded okay to me. Am I coming through okay now, Walt?

MEMBER KIRCHNER: Yes. You're okay now.

CHAIR SUNSERI: Okay. So let me back up. The SDA that was brought to us at the start of this meeting is an SDA that covers the same scope of design, the certified design application that we've been reviewing for the last two years.

There is another SDA coming forward that is the "uprated" NuScale module design. The actions we're being asked to take now have nothing to do with that future SDA. It's only the SDA that covers the certified design scope that we have been reviewing for the last couple of years now. I just wanted to add that clarification. Okay? Any other questions?

MEMBER KIRCHNER: Also just not to correct you, Mr. Chairman, but we actually started the ACRS review of the NuScale design, our first letter report was in May of 2016.

CHAIR SUNSERI: Okay. So quite a while back. Any other comments? Okay. Let's close the public line. I want to check the meeting room one more time, the virtual meeting room. Any members want to make a public comment? Now is your opportunity. Okay. So we'll close off the public comment period.

And Walt we are at this point in time where we are going to transition out of what I'll call the discovery phase of our going through the report preparation phase of these two letters that you mentioned at the start, the blind distribution report and the final letter.

MEMBER MARCH-LEUBA: But we want to go around the table.

MEMBER KIRCHNER: Yes, Mr. Chairman, if we could, could we go around the table to members for any observations or comments that they want to make. And I want to remind everyone this is part of the transcript and public record.

CHAIR SUNSERI: Okay. So go ahead, Walt, facilitate it.

MEMBER KIRCHNER: So members?

MEMBER MARCH-LEUBA: I want to make some comments. As ACRS members, we have to face the official obedience on the record so.

MEMBER KIRCHNER: Jose, let's do the following. Certainly, you and I have pretty much dominated the members' conversation. Let's just go in order and start with Dr. Ballinger.

MEMBER BALLINGER: Not at this time. In the closed session.

MEMBER KIRCHNER: Dr. Bley?

MEMBER BLEY: Nothing additional for me.

MEMBER KIRCHNER: Mr. Brown?

MEMBER BROWN: Nothing else for me right now. Thank you.

MEMBER KIRCHNER: Dr. Dimitrijevic.

MEMBER DIMITRIJEVIC: Well, yes, I will have some comments but they cannot be in the open session. But it is going to be collectively our, you know, taking our position how to address this in the final letter. So no additional comments, no.

MEMBER KIRCHNER: Okay. Thank you. Let me see. I think we go next to -- I'm going to skip Dr. March-Leuba for the moment and go on to Dr. Petti.

MEMBER PETTI: So I just want to say that my perspective on this issue has shifted somewhat based on the real detail that we heard from the staff and some of the discussion of potential operating procedures that were sort of brought up by NuScale. There were some things that I hadn't before that changed my view. And I'm hoping to reflect some of that in the letter. That's it.

MEMBER KIRCHNER: Dr. Rempe?

MEMBER REMPE: Hi. Can you hear me? I'm a little worried about my internet connection, but is the sound coming up?

MEMBER KIRCHNER: We hear you loud and clear.

MEMBER REMPE: Okay. I may also have some changes in my thoughts. But I would like to actually see Ben Bristol's comments in writing so I can think about it. Having something come in last minute is difficult to reflect upon with the screening that's needed. Thank you.

MEMBER KIRCHNER: Dr. Riccardella.

MEMBER RICCARDELLA: Well, you know, I have some comments probably more applicable to the letter writing session. But unfortunately, I'm unable to attend tomorrow. I have a conflict with another engagement so I'm going to say them now.

You know, what I'm hearing is that everyone's judgment and intuition is that sufficient mixing will occur and prevent unacceptable reactivity insertion. But everyone also agrees that more work in the form of detailed analyses are necessary to confirm this judgment. And that's what I keep hearing over and over and over again for, like, weeks now.

But, you know, it comes down to one key question is the timing. I understand from the thermodynamics folks that counts of these types are going to take three to six months to be performed. And the question on timing, you know, it's basically a bipolar question.

Is it necessary to delay the certification of SDA until those calculations are complete? Or is it okay to approve, for us to approve in our letter, that the certification be approved but with the caveat that these calculations need to be completed before the COL application.

And I personally come down on the side of the second point. It's a safety concern. In my opinion, there's no safety issue at this time since we're talking about a paper reactor. There's no reactor that's going to be built or operated until the final piece, the final calculations are approved.

I think that as long as we point in our letter, document in our letter, the need for these calculations and analyses to support the procedures, that I would vote to go ahead with the certification or SDA. That's all I have.

MEMBER KIRCHNER: Thank you, Pete.

MEMBER BLEY: Hello? This is Dennis. If I could get another chance I would appreciate it.

MEMBER KIRCHNER: Yes, sir. Chairman Sunseri?

CHAIR SUNSERI: Walt, I don't have anything else to add at this time.

MEMBER KIRCHNER: Okay. I skipped over Member March-Leuba. Do you want to make a further statement at this point, Jose?

MEMBER MARCH-LEUBA: Yes, I do. But I will let Dennis comment on his. I will let Dennis go first.

MEMBER BLEY: Thank you, Jose. This is very short. I'm getting a little concerned that we're getting good information, useful information today, but we have to write our letter on the design certification based on the application and the SER not on informally -- well, even through a meeting presented, thoughts and ideas that aren't documented in those documents. That was all.

MEMBER KIRCHNER: Thank you, Dennis. Jose.

MEMBER MARCH-LEUBA: Thank you. I will first like to thank Dennis for (audio interference). That was a thought. But my thoughts, these are my closing remarks on the record are more detailed than this. And I want to take a reality check and take a trip back to memory Lane.

Let's go back to December 2019. We have an FSAR. We have a safety evaluation report approved. We are ready for going to lawyers and doing signatures.

And everybody, by everybody I mean the applicant, the staff and ACRS knew the downcomer would (audio interference) when the riser uncovers. But the staff and the applicant had to spend many years working on a boron solution to handle all those calculations.

And everybody in the universe, but one person, and now I know it was two because there is a different opinion, was of the opinion that that was a problem. Everybody, minus two, thought that was okay. We will develop procedures. We will go ahead. Everything is fine.

Through the (audio interference) a guy finally performed the formal calculation and took it seriously. They discovered, because before they were saying there were various -- yet the crucial (audio interference) de-borates, but there is no mechanism to get that water into the core. When they run the calculation, they didn't find one mechanism but two mechanisms by which the water could get into the core.

They found two mechanisms by which the water could get into the core. That was the normal evolution of the AL offs. They don't require any failures.

Now we're back in July 2020, and I'm being told exactly the same thing. There is no mechanism to get the water into the core and cause damage. They have not calculated it. We have not done a scientific estimation of what the problem is. And there is a lot of talk. A lot of high waving, but figures, looking at all the tests but no calculation.

We, I mean, learned our lesson from the December 2019 signature. I just cannot believe that the staff is here to insist that a one dollar per connect pre-activity run have different consequences. I believe that it is off by a factor of five, and it should be six, seven, eight.

But I cannot believe that that payment is -- and the staff is here. So that's all I wanted to say. I certainly learned my lesson in December 2019, and I think we're making the same mistake now. Thank you very much, Mr. Chairman.

MEMBER KIRCHNER: Thank you, Jose. I just caution again that everybody -- the ACRS will only make a statement through its final letter report on the subject. You speak too liberally in categorizing other members' positions. So don't include me in with everybody else. And we recognize your point.

So at this point, Mr. Chairman, I think I turn it back over to you. I've got my eye on the hour. It's coming up on 5:30 Eastern Time.

Our next piece of business would be to go off the record to start letter writing. I will leave it to you to decide whether we start fresh first thing in the morning or we continue this afternoon. Thank you.

MR. MOORE: Mr. Chairman, this is Scott. For the staff, could you go over the sequence of events? Are we going to go to a closed proprietary session?

CHAIR SUNSERI: Yes. If I can finish without being interrupted, I'm going to do that.

MR. MOORE: Thank you.

CHAIR SUNSERI: So, Walt, I just wanted to confirm that there is no closed meeting. We're finished with all of our presentations?

MEMBER KIRCHNER: Yes, you're correct. We do not require a closed meeting.

CHAIR SUNSERI: Okay. Very good. So I'm going to recommend that we do not conduct any further business tonight. That you have circulated proposed draft letters around. I think the members' time would be best served thinking about those draft proposals bouncing off what we heard today and getting our thoughts ready for report preparation for tomorrow.

So that's what I would like to do is close up today. We will soon go off the transcript. We will pick up at 9:30 tomorrow morning. It will be an open session, but it will be letter writing without a transcriber.

And the first course of business then would be to do as we normally do, you will introduce the letter. We'll cover, you know, with conclusions and recommendations, and you will facilitate the review of that letter. Is that the --

MEMBER KIRCHNER: Yes. Thank you, sir. That would work well. So we'll start tomorrow at 9:30. And I will read the letter first. And then we'll follow our normal procedures of major comments and then proceed.

CHAIR SUNSERI: So we will release this transcriber after today. As far as staff engagement, as you pointed out before, let's just be clear on this, this is the members' deliberation. So we will only have need for staff engagement if we encounter a question of fact or if there is a question of fact that we don't understand, and we would ask for some clarification on that. But no further back and forth deliberation with the staff. Is that understood by everyone? Okay.

And so now I would ask if anybody has any questions. And then, if so, so we'll pick up with the blind resolution letter tomorrow. We'll work it until it's done, however long it takes. And then we will go to the final letter report after that.

And right now I know people have questions for me. Are we going to work through Friday or whatever? I can't say. Right now we're scheduled to work through Saturday morning. And I think we just have to get through more of this week before we can make a judgment on what it looks like as far as finishing up.

So now I'll pause and ask does anybody have any questions about the sequence of events for tomorrow or the rest of the week?

MR. MOORE: This is Scott. I don't have any questions. Mike Snodderly, do you?

MR. SNODDERLY: No. Just I'm going to be online until 7:00 p.m. and then I have to go to another location so I won't be online after that. But I will check things early in the morning. So if people need documents and things try to get that to me in the next hour here, please.

MR. MOORE: And, Mike, does Sandra have the document that she'll need for tomorrow morning?

MR. SNODDERLY: Yes, we are ready to go. And it has the latest references in it.

MR. MOORE: Great. Thank you.

CHAIR SUNSERI: Thank you, Mike.

MEMBER BROWN: Can I confirm something? This is Charlie. The correct revisions for the boron letter are Rev. 2 and for the NuScale letter is Rev. 5 based on stuff that has been placed in the files?

CHAIR SUNSERI: That's correct, Charlie.

MEMBER BROWN: Okay. Thank you.

CHAIR SUNSERI: Okay. Well, then, thank you for everyone's participation today, input. And it's 5:33. We are now adjourned. Thank you.

(Whereupon, the above-entitled matter went off the record at 5:33 p.m.)

# Back-up Slides

RES Slides for

ACRS Meeting 7/21-22/2020

# SET / IET Overview

- Hibiki and Ishii
- Boesmans and Berghmans
- LINX
- CCTF
- SCTF
- PKL

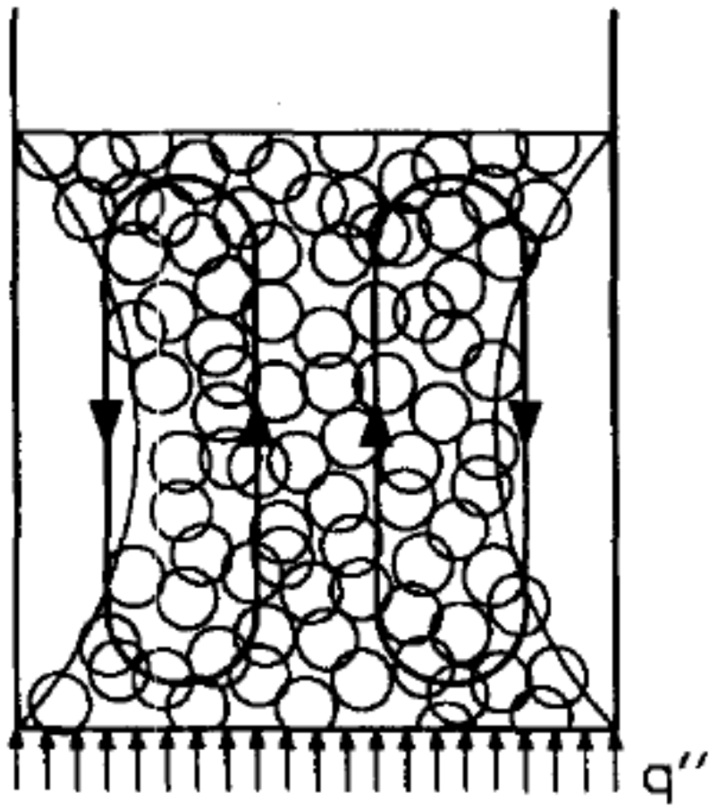
# Literature Review

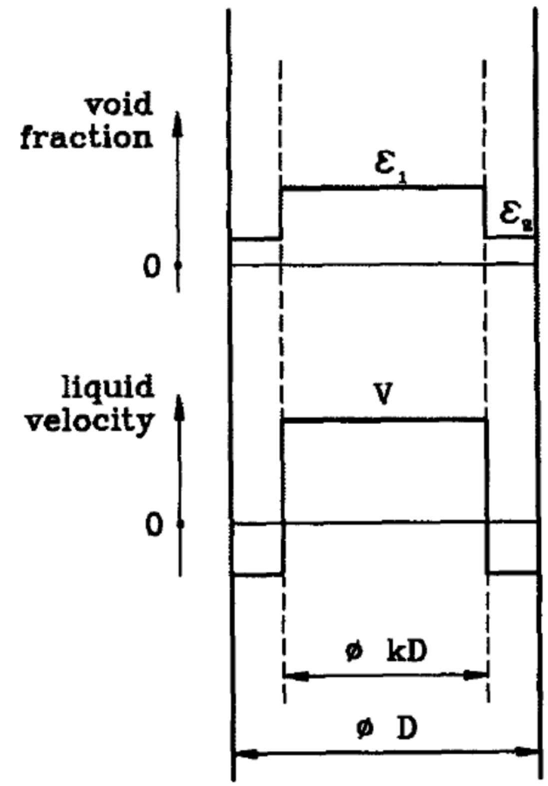
- Hibiki and Ishii summarized findings over many experimental campaigns that internal recirculation occurs near pool boiling conditions in large pipe geometries and bundle geometries
  - A key process that affects the 3D flow field is channeling of voids into a central column
- At LINX facility, voiding in adiabatic conditions drove internal recirculation
- At CCTF, radial power differences enhanced internal recirculation
- At PKL facility, internal recirculation homogenized the axial and radial boron distribution

# Hibiki-Ishii Review

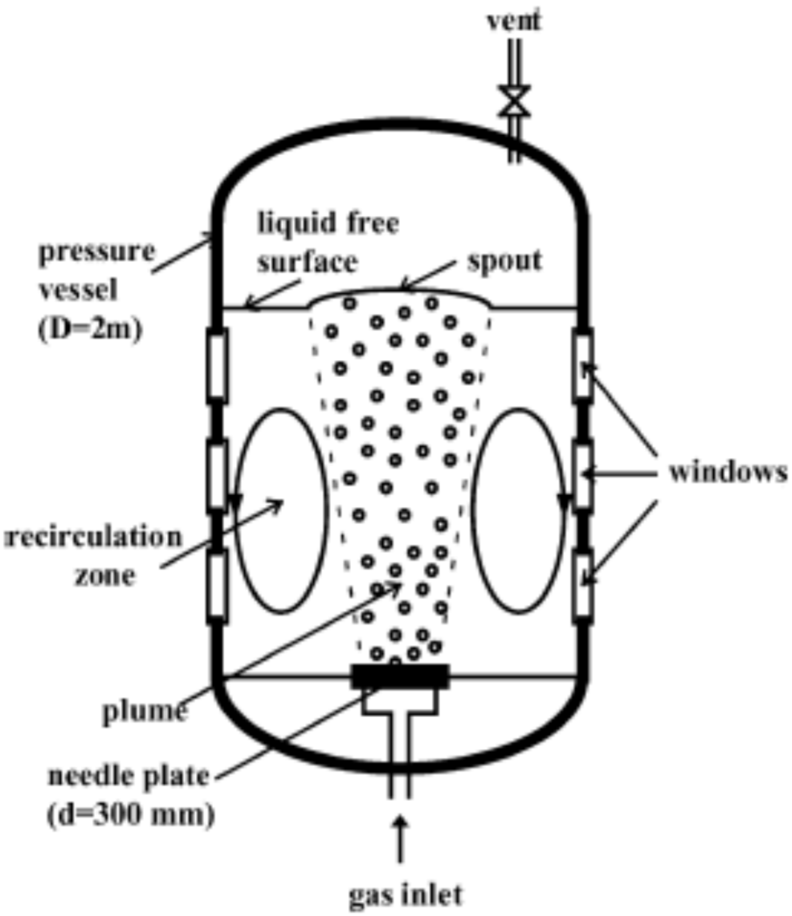
| Investigator | Fluid system | Pipe diameter $D$ (m) | Number of data | Superficial gas velocity $\langle j_g \rangle$ (m/s) | Superficial liquid velocity $\langle j_f \rangle$ (m/s) | Mixture volumetric flux $\langle j \rangle$ (m/s) | System pressure $P$ (MPa) | Bubble injection method |
|---|---|---|---|---|---|---|---|---|
| Hibiki and Ishii [21,25] | Nitrogen–water | 0.0508, $L/D = 108$ | 73 | 0.0320–0.484 | 0.00–0.596 | 0.0320–1.02 | 0.1 | No horizontal section |
| Hibiki and Ishii [21] | Nitrogen–water | 0.102, $L/D = 53.9$ | 59 | 0.0373–0.286 | 0.0109–0.387 | 0.0482–0.655 | 0.1 | No horizontal section |
| Hibiki and Ishii [22] | Nitrogen–water | 0.102, $L/D = 53.9$ | 12 | 0.0349–0.146 | 0.0389– 0.198 | 0.0754–0.336 | 0.1 | Horizontal section |
| Hills [7] | Air–water | 0.150, $L/D = 70.0$ | 301 | 0.040–0.62 | 0.0–0.50 | 0.040–0.85 | 0.1 | Low flow data |
| Hills [7] | Air–water | 0.150, $L/D = 70.0$ | 93 | 0.10–3.5 | 0.0–2.6 | 0.10–6.1 | 0.1 | High flow data |
| Hashemi et al. [16] | Air–water | 0.305, $L/D = 9.41$ | 16 | 0.0100–1.16 | 0.0–0.060 | 0.0300–1.22 | 0.1 | No horizontal section |
| Hirao et al. [11,12] | Steam–water | 0.102, $L/D = 55.3$ | 23 | N/A | N/A | 0.720–3.43 | 0.1, 0.5, 1.5 | Vertical and L-shaped pipes |
| Ohnuki and Akimoto [18] | Air–water | 0.480, $L/D = 4.2$ | 32 | N/A | N/A | 0.0284–1.01 | 0.1 | Sinter inlet |
| Ohnuki and Akimoto [18] | Air–water | 0.480, $L/D = 4.2$ | 73 | N/A | N/A | 0.0114–1.02 | 0.1 | Nozzle inlet |

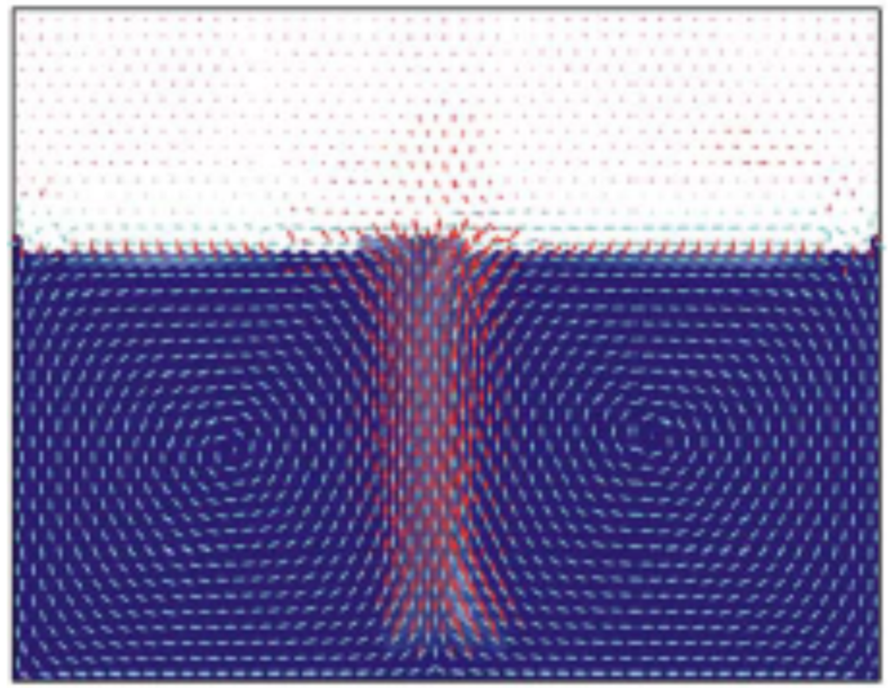
# Boesmans and Berghmans



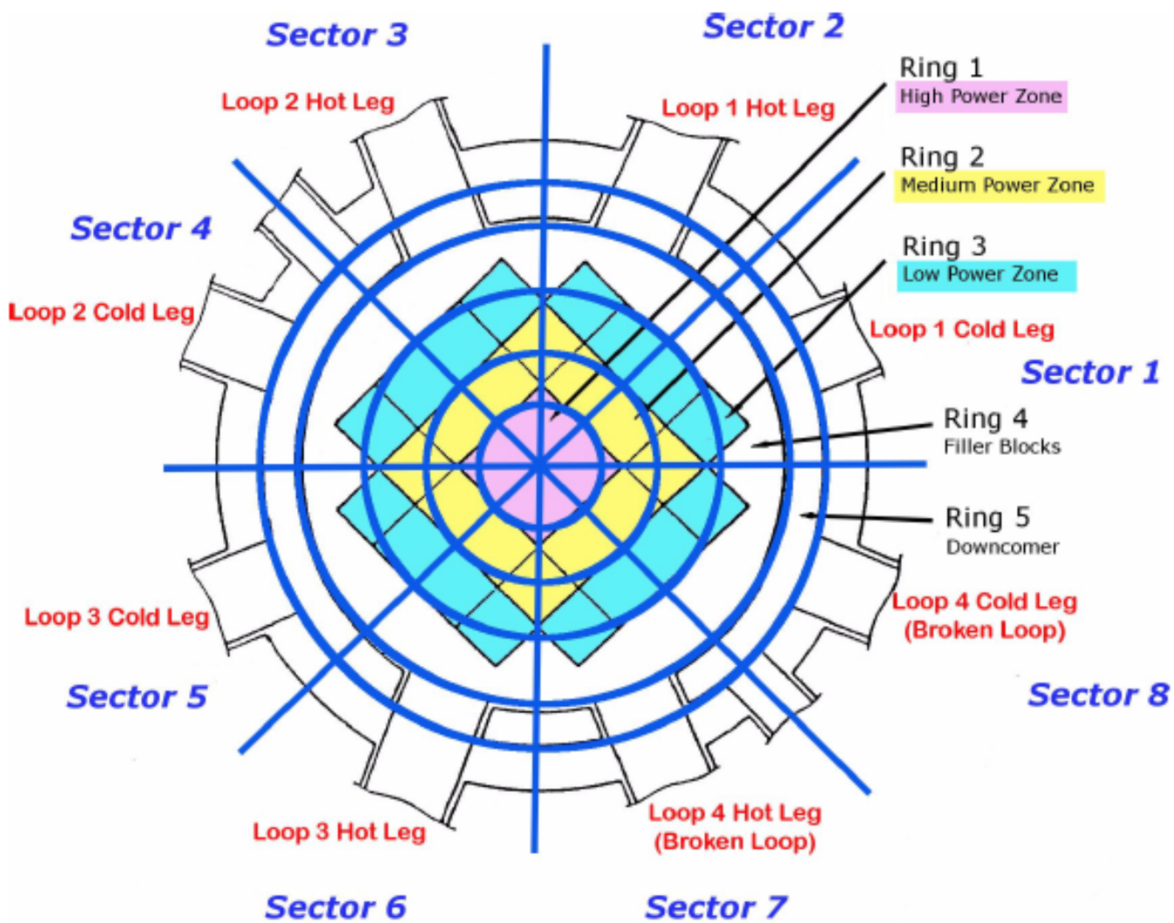



# LINX

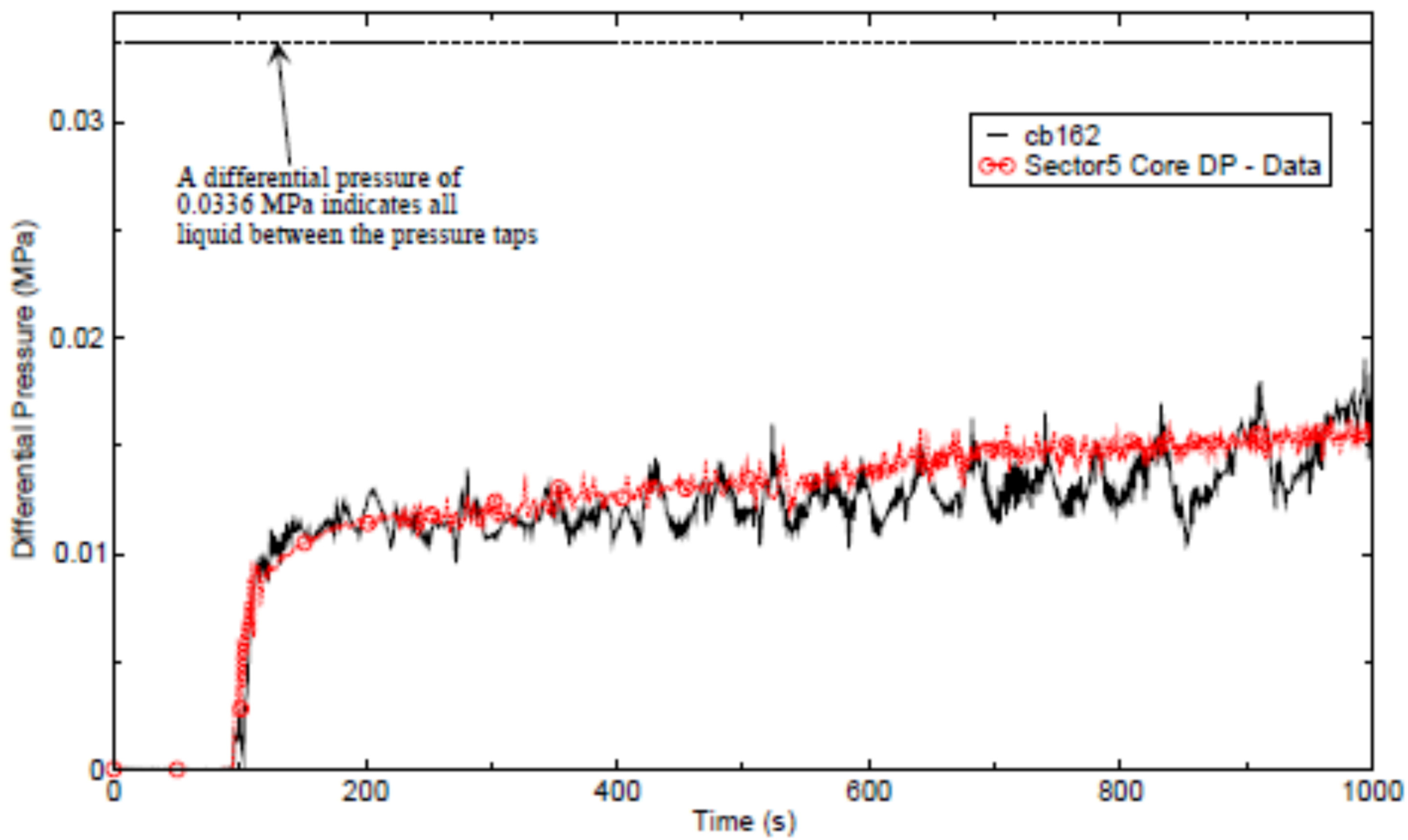

vent
pressure
vessel
(D=2m)
liquid free
surface
spout
windows
recirculation
zone
plume
needle plate
(d=300 mm)
gas inlet



# CCTF

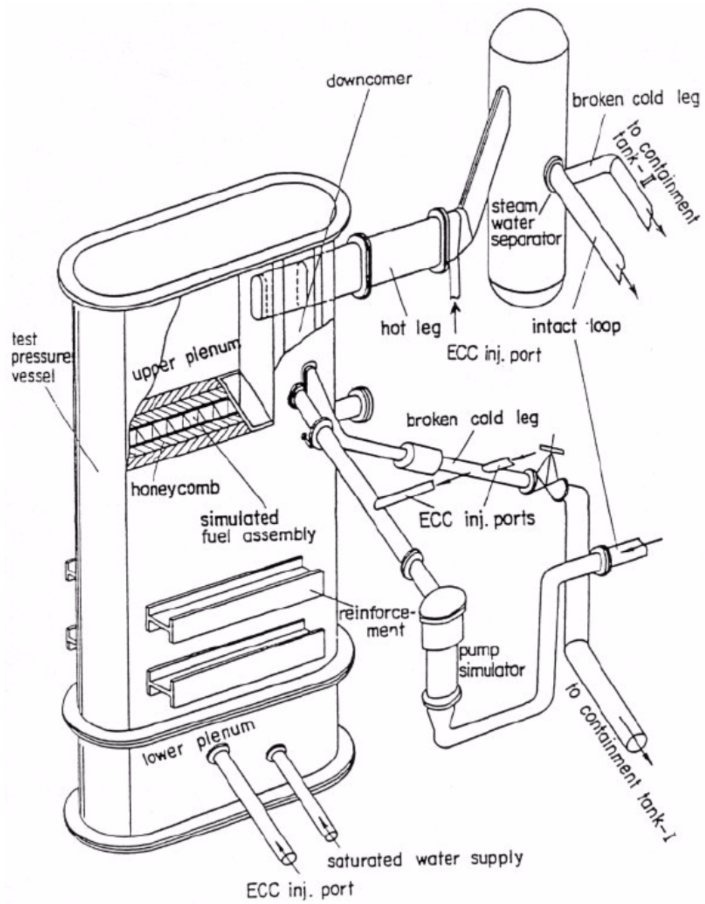

Sector 3
Sector 2
Loop 2 Hot Leg
Loop 1 Hot Leg
Ring 1
High Power Zone
Ring 2
Medium Power Zone
Sector 4
Ring 3
Low Power Zone
Loop 2 Cold Leg
Loop 1 Cold Leg
Sector 1
Ring 4
Filler Blocks
Ring 5
Downcomer
Loop 3 Cold Leg
Loop 4 Cold Leg
(Broken Loop)
Sector 5
Sector 8
Loop 3 Hot Leg
Loop 4 Hot Leg
(Broken Loop)
Sector 6
Sector 7

# CCTF

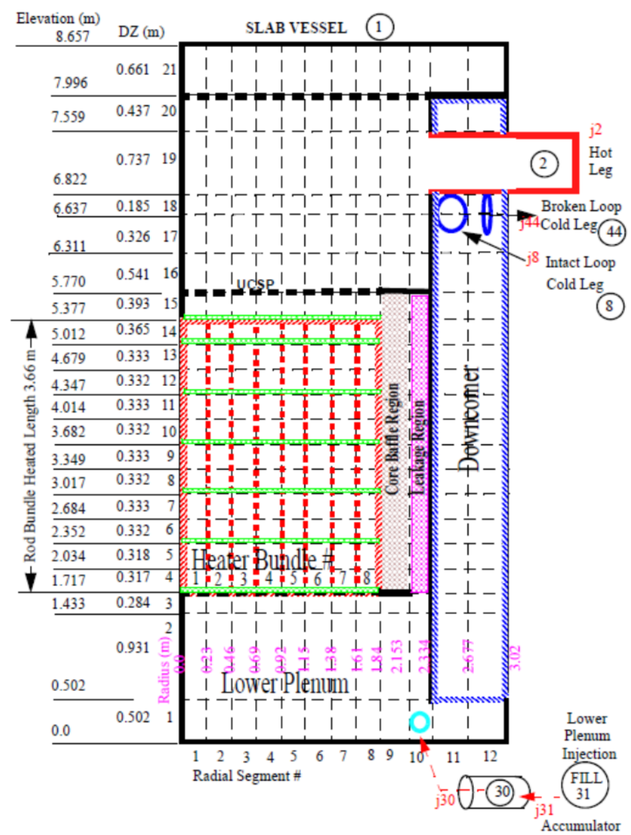


A differential pressure of
0.0336 MPa indicates all
liquid between the pressure taps
cb162
Sector5 Core DP - Data
Differential Pressure (MPa)
0.03
0.02
0.01
0
0
200
400
600
800
1000
Time (s)

# SCTF

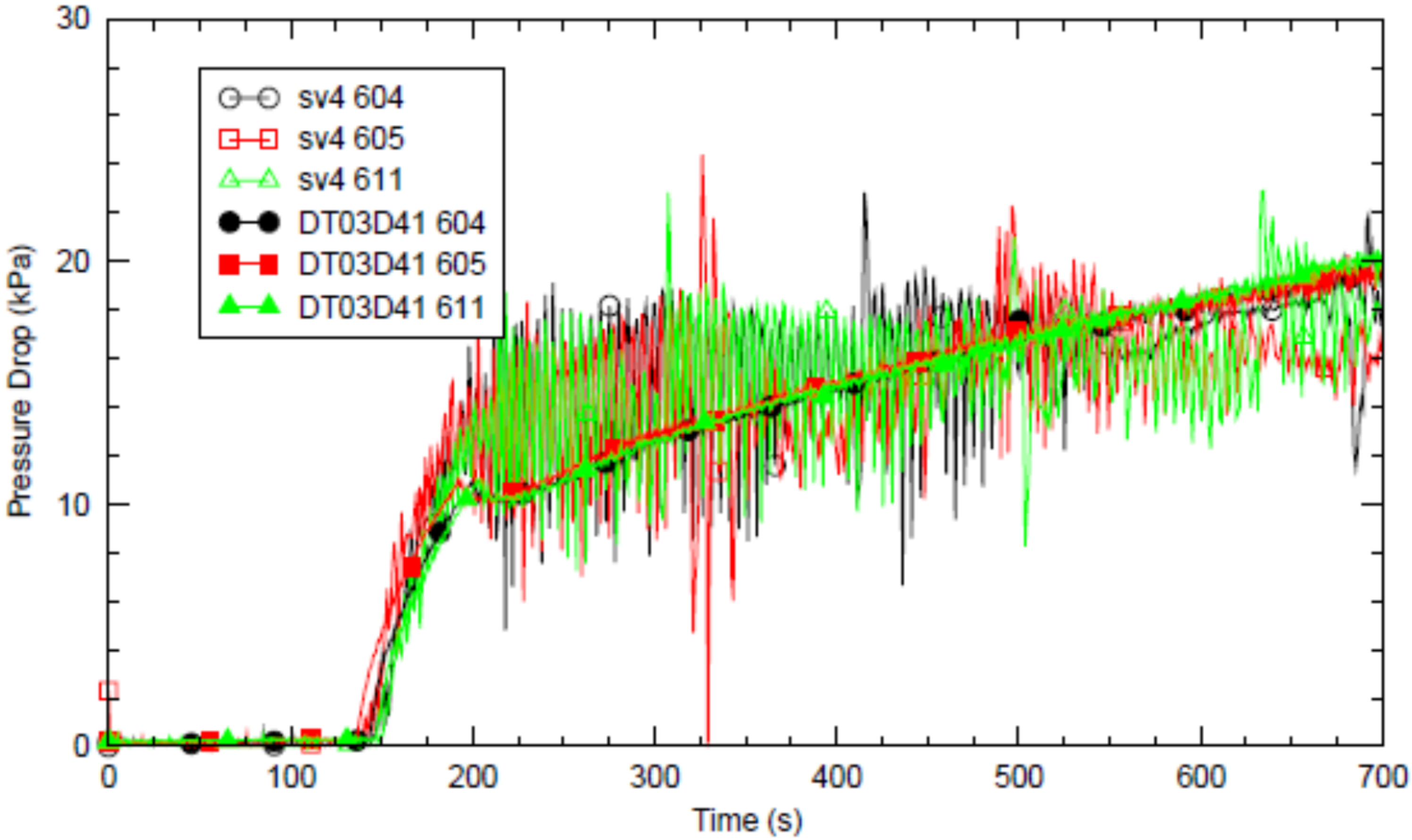


downcomer
broken cold leg
to containment tank-II
steam water separator
test pressure vessel
upper plenum
hot leg
ECC inj. port
intact loop
broken cold leg
honeycomb
simulated fuel assembly
ECC inj. ports
reinforcement
pump simulator
lower plenum
to containment tank-I
saturated water supply
ECC inj. port

Elevation (m)
DZ (m)
SLAB VESSEL
1
Hot Leg
2
j2
Broken Loop Cold Leg
44
j44
j8
Intact Loop Cold Leg
8
UCSP
Rod Bundle Heated Length 3.66 m
Heater Bundle #
Core Baffle Region
Leakage Region
Downcomer
Lower Plenum
Radius (m)
Radial Segment #
Lower Plenum Injection
FILL 31
30
j30
j31
Accumulator

# SCTF

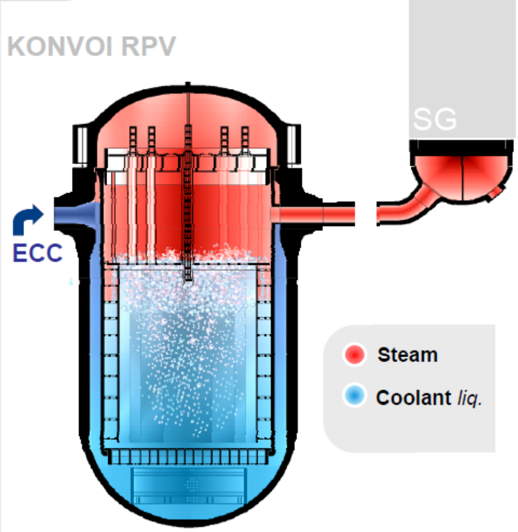


30
20
10
0
0
100
200
300
400
500
600
700
Pressure Drop (kPa)
Time (s)
sv4 604
sv4 605
sv4 611
DT03D41 604
DT03D41 605
DT03D41 611

# Primärkreislauf Primary Circuit Reactor Coolant System (PKL) Information Follows

# PKL

## A Postulated Scenario

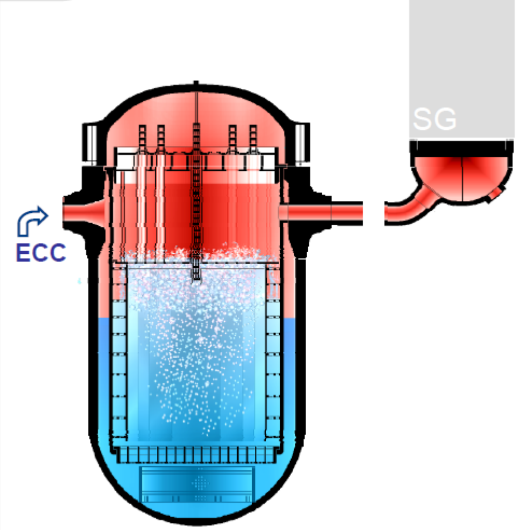



- High flow resistance in COL (partially filled)
- High pressure in upper plenum

→ High pressure in UP effectuates low swell level in core

→ Small mixing volume in RPV

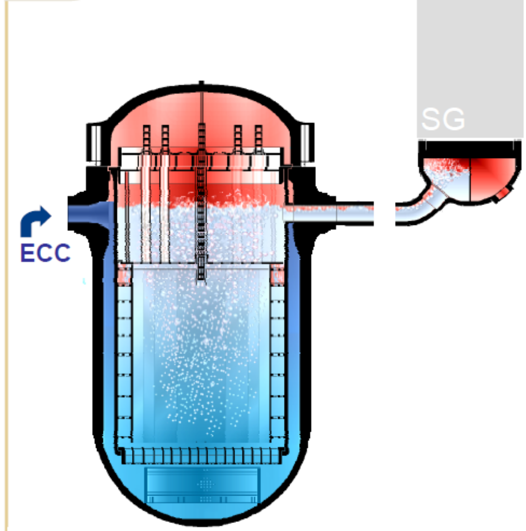
## B PKL at SOT




- ECC just compensates for evaporation in core
  → very low ECC flow rates
- Hot side swell levels just covers core

→ Small mixing volume in RPV

## C PKL Test Result



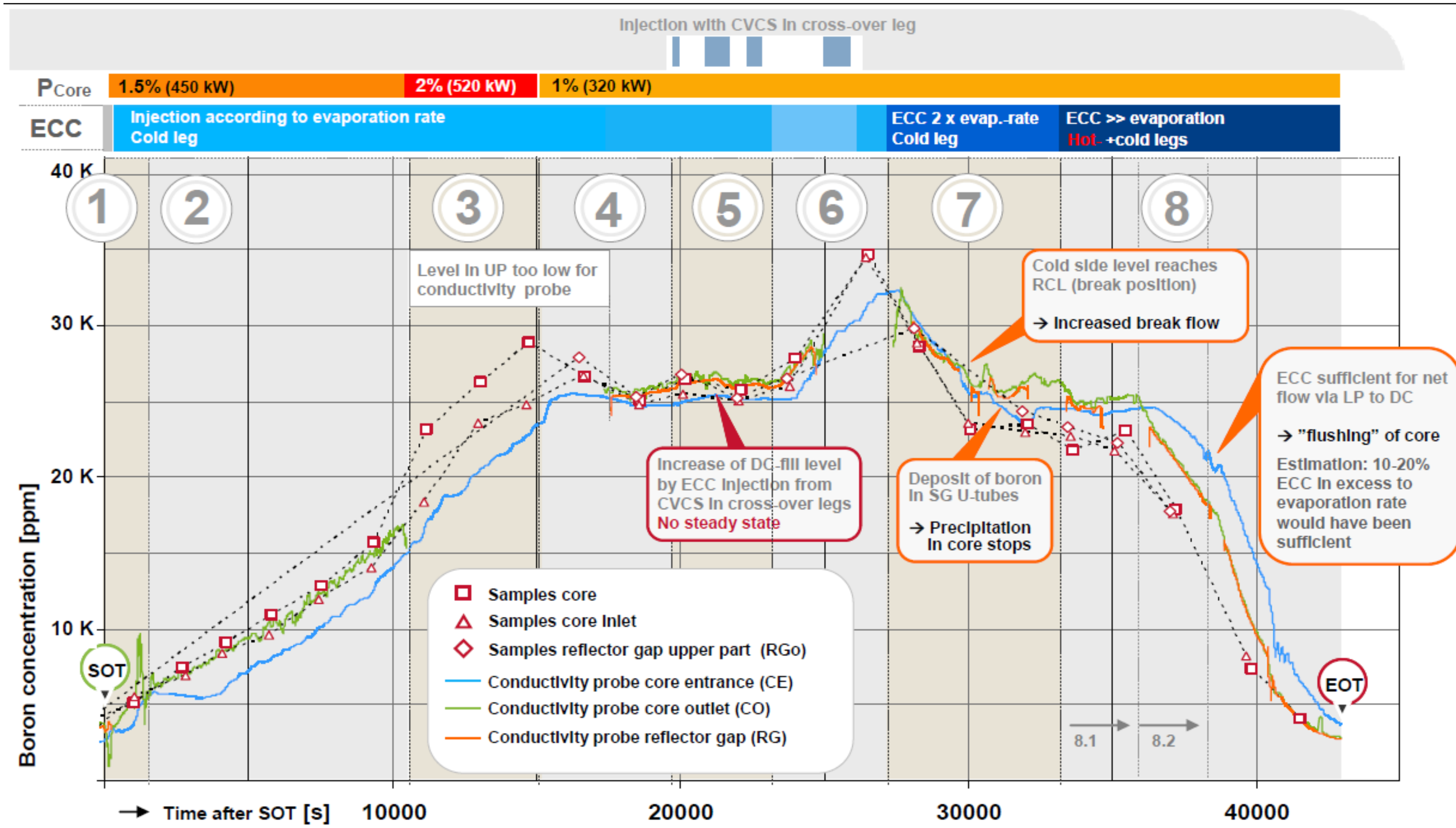

**Realistic power and ECC flow rates:**

→ DC completely filled, hot side swell level reaches SG inlet chambers

→ Deposit of boron into SG U-tubes
  → boron precipitation in core stagnates

→ Large mixing volumes

# PKL



Injection with CVCS in cross-over leg
PCore
1.5% (450 kW)
2% (520 kW)
1% (320 kW)
ECC
Injection according to evaporation rate
Cold leg
ECC 2 x evap.-rate
Cold leg
ECC >> evaporation
Hot- +cold legs
40 K
30 K
20 K
10 K
Boron concentration [ppm]
1
2
3
4
5
6
7
8
Level in UP too low for conductivity probe
Cold side level reaches RCL (break position)
→ Increased break flow
ECC sufficient for net flow via LP to DC
→ "flushing" of core
Estimation: 10-20% ECC in excess to evaporation rate would have been sufficient
Increase of DC-fill level by ECC injection from CVCS in cross-over legs
No steady state
Deposit of boron in SG U-tubes
→ Precipitation in core stops
Samples core
Samples core inlet
Samples reflector gap upper part (RGo)
Conductivity probe core entrance (CE)
Conductivity probe core outlet (CO)
Conductivity probe reflector gap (RG)
SOT
EOT
8.1
8.2
→ Time after SOT [s]
10000
20000
30000
40000

# SET/IET References

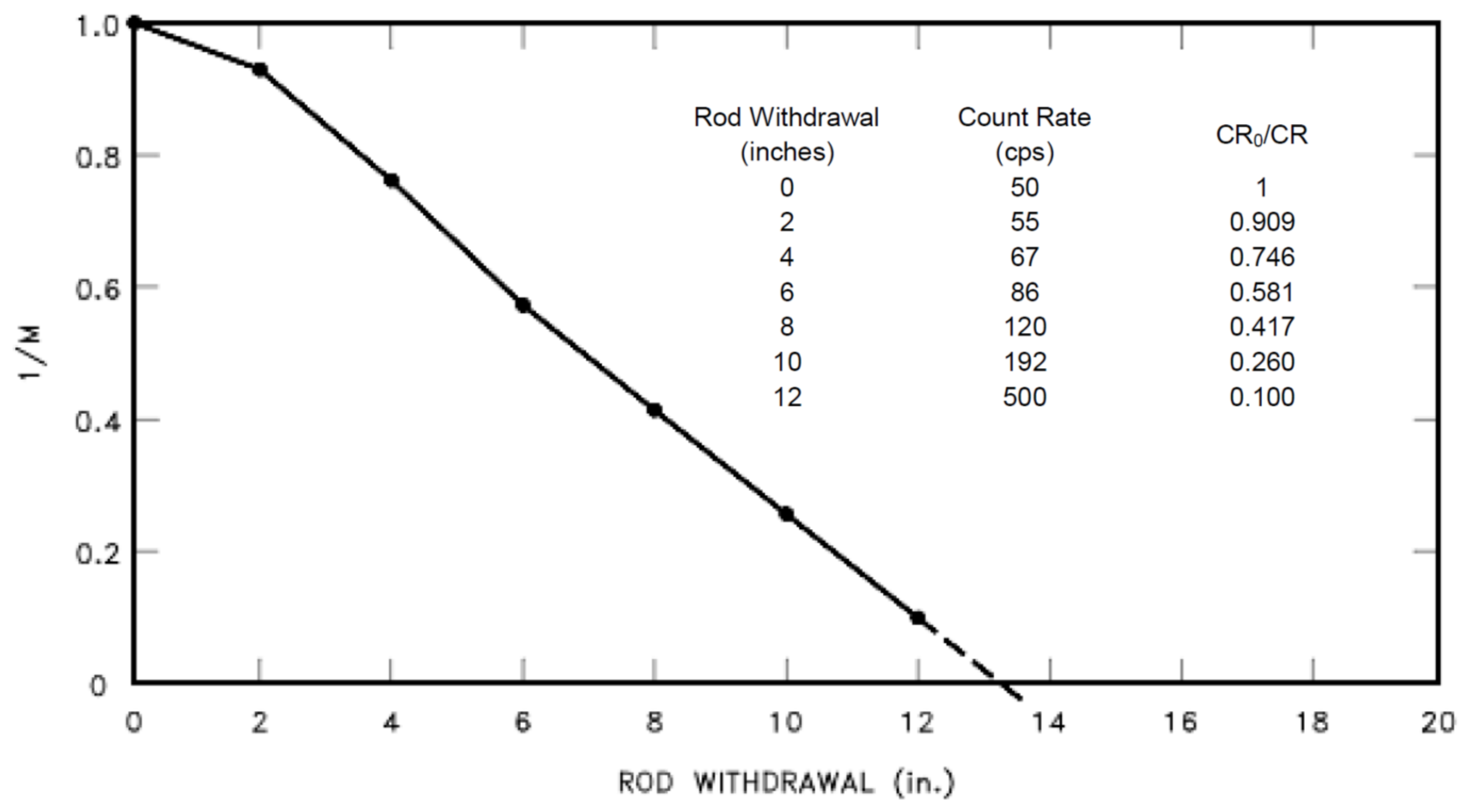

- Hibiki, T. and Ishii, M., "One-dimensional Drift Flux model for Two-phase Flow in a Large Diameter Pipe," *Intl. Journal of Heat and Mass Transfer* **46** (2003) pp.1773–1790.
- Staedke, H., Franchello, G., Worth, B., Graf, U., Romsedt, P., Kumbaro, A., et al., "Advanced Three-dimensional Two-phase Flow Simulation Tools for Application to Reactor Safety (ASTAR)," *Nucl. Engr. And Design*, **235** (2005) pp. 379-400.
- Bosemans, B and Berghmans, J., "Level swell in pool boiling with liquid circulation," *Intl. Journal of Heat and Mass Transfer* **38** (1995) pp.989-998.
- NUREG/IA-0127, "Reactor Safety Issues Resolved by the 2D/3D Program," July 1993 (ADAMS Accession No. ML062560279)
- "Analysis Report on SCTF Core-I and II Reflood Test," prepared by Japan Atomic Energy Research Institute, JAERI-Memo-01-348.
- TRACE V5.0 Assessment Manual Appendix C: Integral Effects Tests
- PKL III G5.1 Test Report PTCTP-G/2011/en/0004 Rev. B, "Investigation on Boron Precipitation following a Large Break LOCA," March 2011 (ADAMS Accession No. ML14099A208).

# Monitoring Subcritical Margin

- Similar to startup procedures, ex-core nuclear instrumentation can be used to monitor subcritical margin.
- Subcritical multiplication monitoring is used with 1/M plots typically to predict critical rod position.

# 1/M Plot

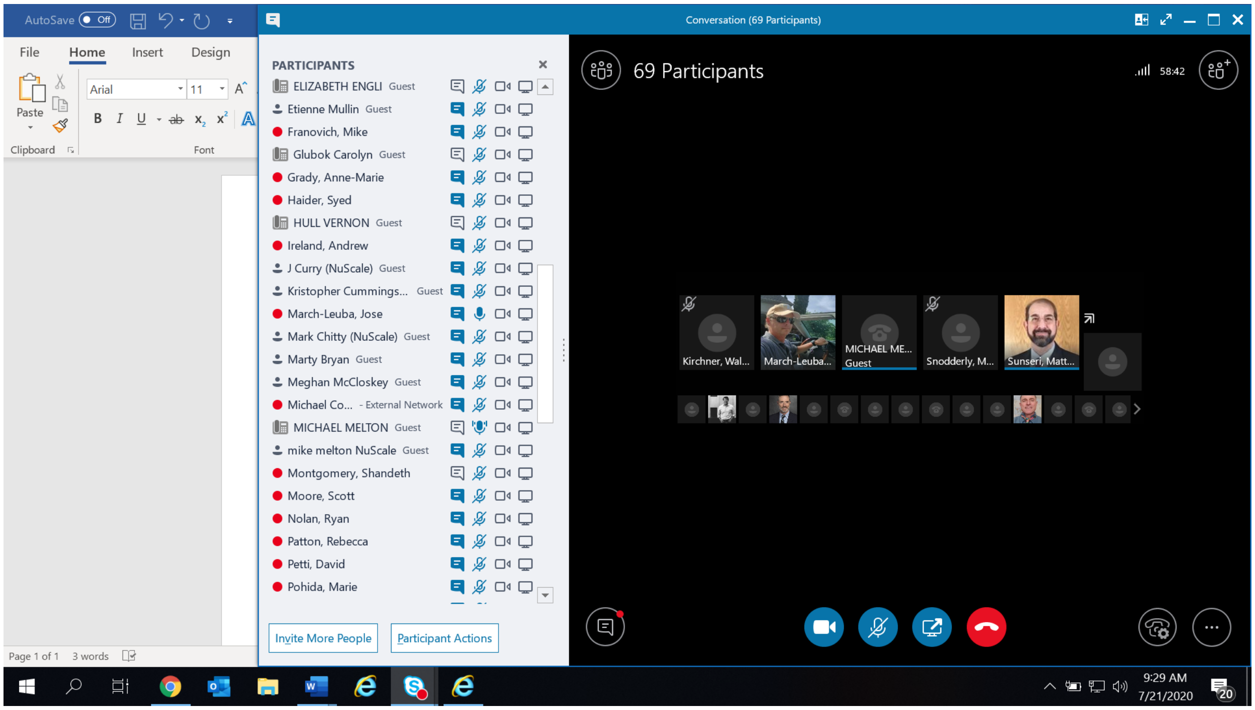
## (from DOE Fundamentals Handbook)



# Timing of Downcomer Dilution

| Time of ECCS Actuation | Approximate DC Concentration post-ECCS | Reactor Power | Steaming Rate | Time to reach 100 ppm | Time to reach 10 ppm |
|---|---|---|---|---|---|
| seconds | ppm | %RTP | kg/sec | days | days |
| 1700 | 1000 | 1.0 | 0.74 | 0.96 | 10.3 |
| 2800 | 900 | 1.0 | 0.74 | 0.86 | 9.3 |
| 3300 | 800 | 1.0 | 0.74 | 0.77 | 8.3 |
| 1700 | 1000 | 0.5 | 0.37 | 1.89 | 20.6 |
| 2800 | 900 | 0.5 | 0.37 | 1.70 | 18.5 |
| 3300 | 800 | 0.5 | 0.37 | 1.49 | 16.5 |
| 1700 | 1000 | 0.2 | 0.15 | 4.70 | 51.5 |
| 2800 | 900 | 0.2 | 0.15 | 4.19 | 46.3 |
| 3300 | 800 | 0.2 | 0.15 | 3.68 | 41.1 |

At 9:30 am


Conversation (69 Participants)
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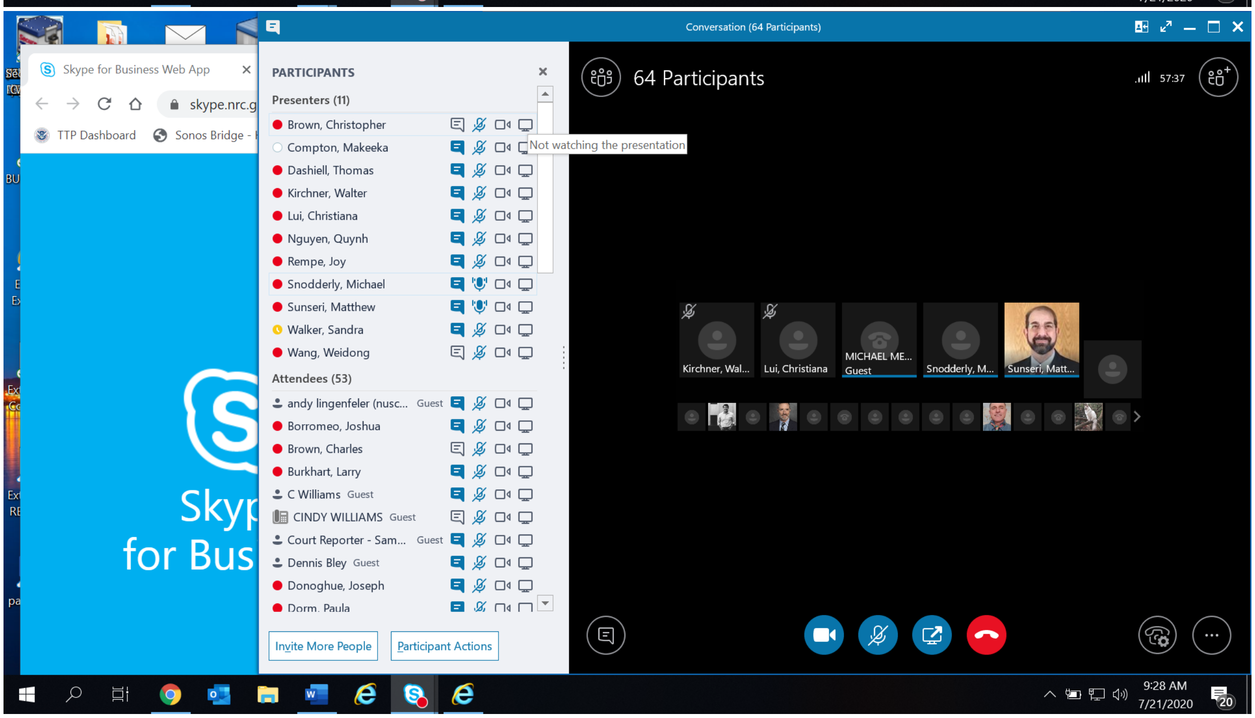
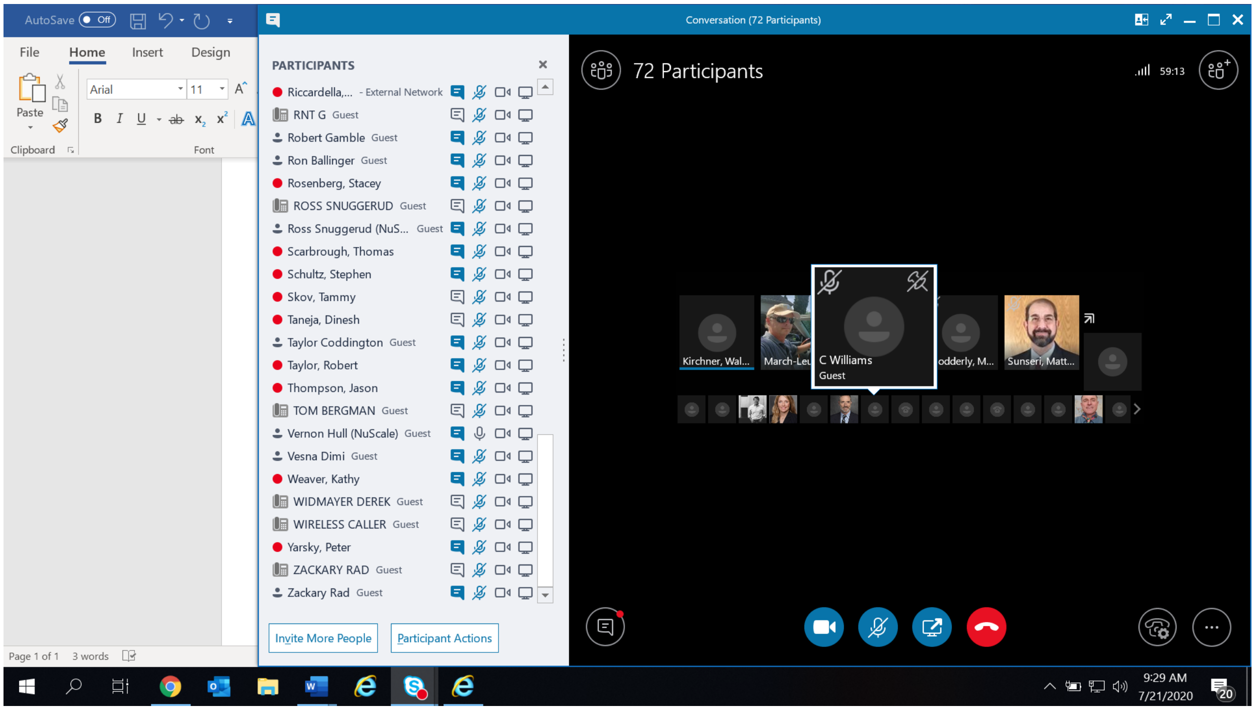
ELIZABETH ENGLI Guest
Etienne Mullin Guest
Franovich, Mike
Glubok Carolyn Guest
Grady, Anne-Marie
Haider, Syed
HULL VERNON Guest
Ireland, Andrew
J Curry (NuScale) Guest
Kristopher Cummings... Guest
March-Leuba, Jose
Mark Chitty (NuScale) Guest
Marty Bryan Guest
Meghan McCloskey Guest
Michael Co... - External Network
MICHAEL MELTON Guest
mike melton NuScale Guest
Montgomery, Shandeth
Moore, Scott
Nolan, Ryan
Patton, Rebecca
Petti, David
Pohida, Marie
Invite More People
Participant Actions
69 Participants
9:29 AM
7/21/2020


Conversation (64 Participants)
Skype for Business Web App
PARTICIPANTS
Presenters (11)
Brown, Christopher
Compton, Makeeka
Not watching the presentation
Dashiell, Thomas
Kirchner, Walter
Lui, Christiana
Nguyen, Quynh
Rempe, Joy
Snodderly, Michael
Sunseri, Matthew
Walker, Sandra
Wang, Weidong
Attendees (53)
andy lingenfelter (nusc... Guest
Borromeo, Joshua
Brown, Charles
Burkhart, Larry
C Williams Guest
CINDY WILLIAMS Guest
Court Reporter - Sam... Guest
Dennis Bley Guest
Donoghue, Joseph
Dorm, Paula
Invite More People
Participant Actions
64 Participants
9:28 AM
7/21/2020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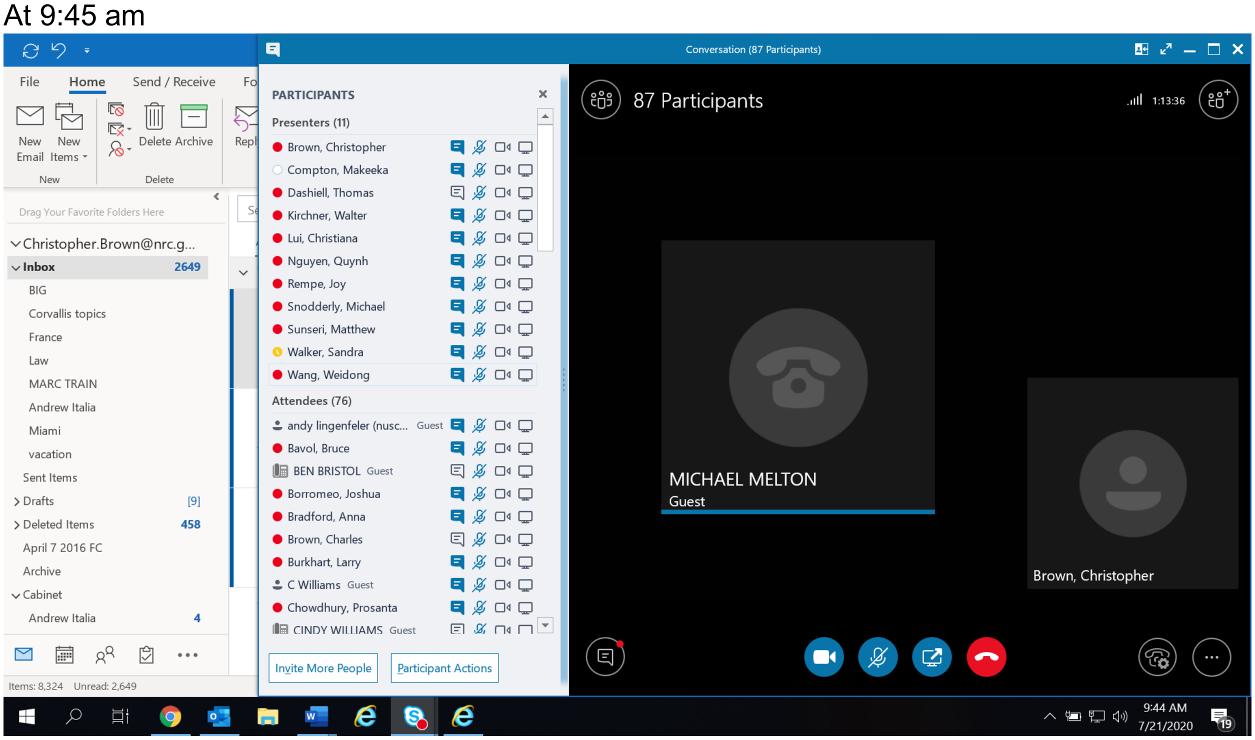
Riccardella,... - External Network
RNT G Guest
Robert Gamble Guest
Ron Ballinger Guest
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Scarbrough, Thomas
Schultz, Stephen
Skov, Tammy
Taneja, Dinesh
Taylor Coddington Guest
Taylor, Robert
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Vesna Dimi Guest
Weaver, Kathy
WIDMAYER DEREK Guest
WIRELESS CALLER Guest
Yarsky, Peter
ZACKARY RAD Guest
Zackary Rad Guest
Invite More People
Participant Actions
72 Participants
59:13
Kirchner, Wal...
March-Leu
C Williams
Guest
odderly, M...
Sunseri, Matt...
9:29 AM
7/21/2020

At 9:45 am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Kirchner, Walter
Lui, Christiana
Nguyen, Quynh
Rempe, Joy
Snodderly, Michael
Sunseri, Matthew
Walker, Sandra
Wang, Weidong
Attendees (76)
andy lingenfeler (nusc... Guest
Bavol, Bruce
BEN BRISTOL Guest
Borromeo, Joshua
Bradford, Anna
Brown, Charles
Burkhart, Larry
C Williams Guest
Chowdhury, Prosanta
CINDY WILLIAMS Guest
Invite More People
Participant Actions
87 Participants
1:13:36
MICHAEL MELTON
Guest
Brown, Christopher
Christopher.Brown@nrc.g...
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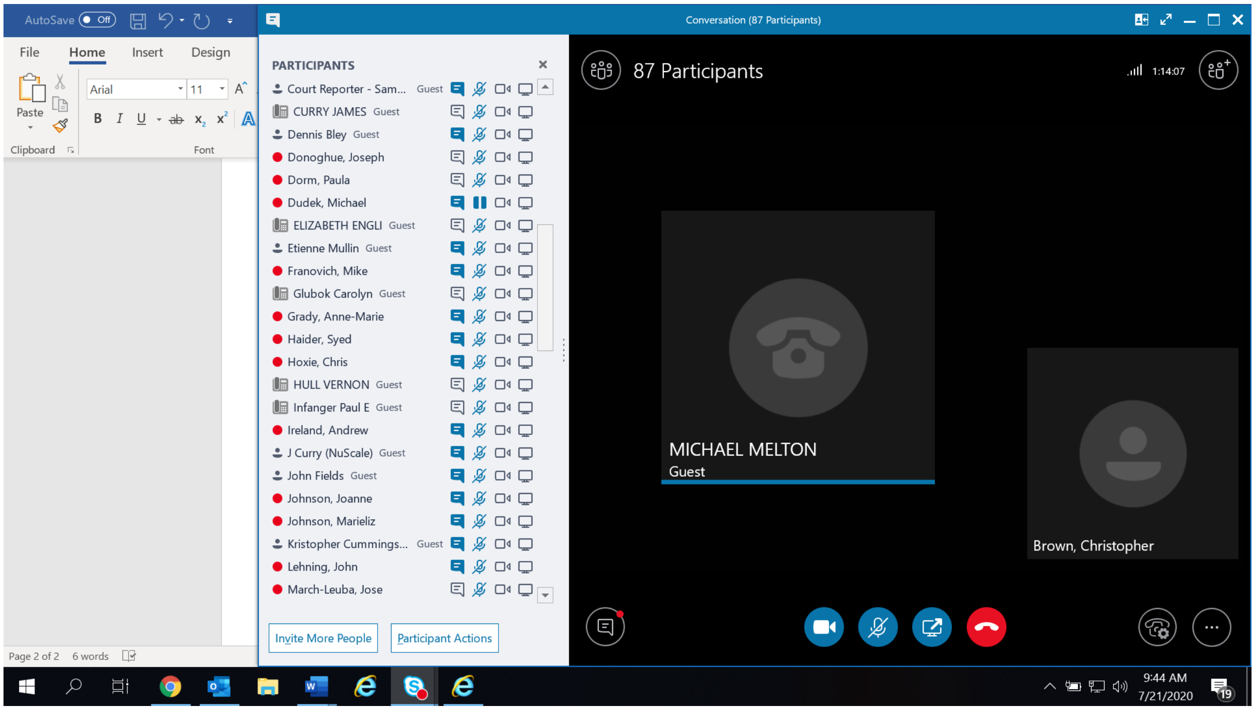
Items: 8,324 Unread: 2,649
9:44 AM
7/21/2020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Page 2 of 2 6 words
Conversation (87 Participants)
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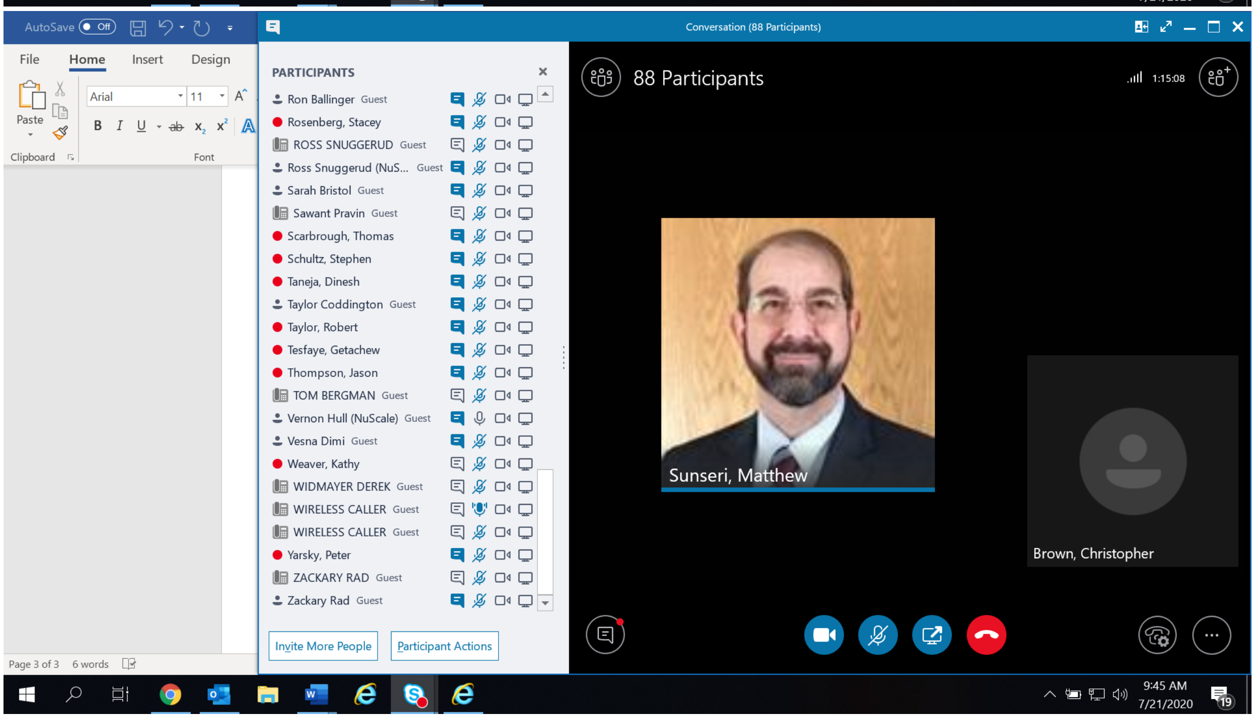
Court Reporter - Sam... Guest
CURRY JAMES Guest
Dennis Bley Guest
Donoghue, Joseph
Dorm, Paula
Dudek, Michael
ELIZABETH ENGLI Guest
Etienne Mullin Guest
Franovich, Mike
Glubok Carolyn Guest
Grady, Anne-Marie
Haider, Syed
Hoxie, Chris
HULL VERNON Guest
Infanger Paul E Guest
Ireland, Andrew
J Curry (NuScale) Guest
John Fields Guest
Johnson, Joanne
Johnson, Marieliz
Kristopher Cummings... Guest
Lehning, John
March-Leuba, Jose
Invite More People
Participant Actions
87 Participants
1:14:07
MICHAEL MELTON
Guest
Brown, Christopher
9:44 AM
7/21/2020
19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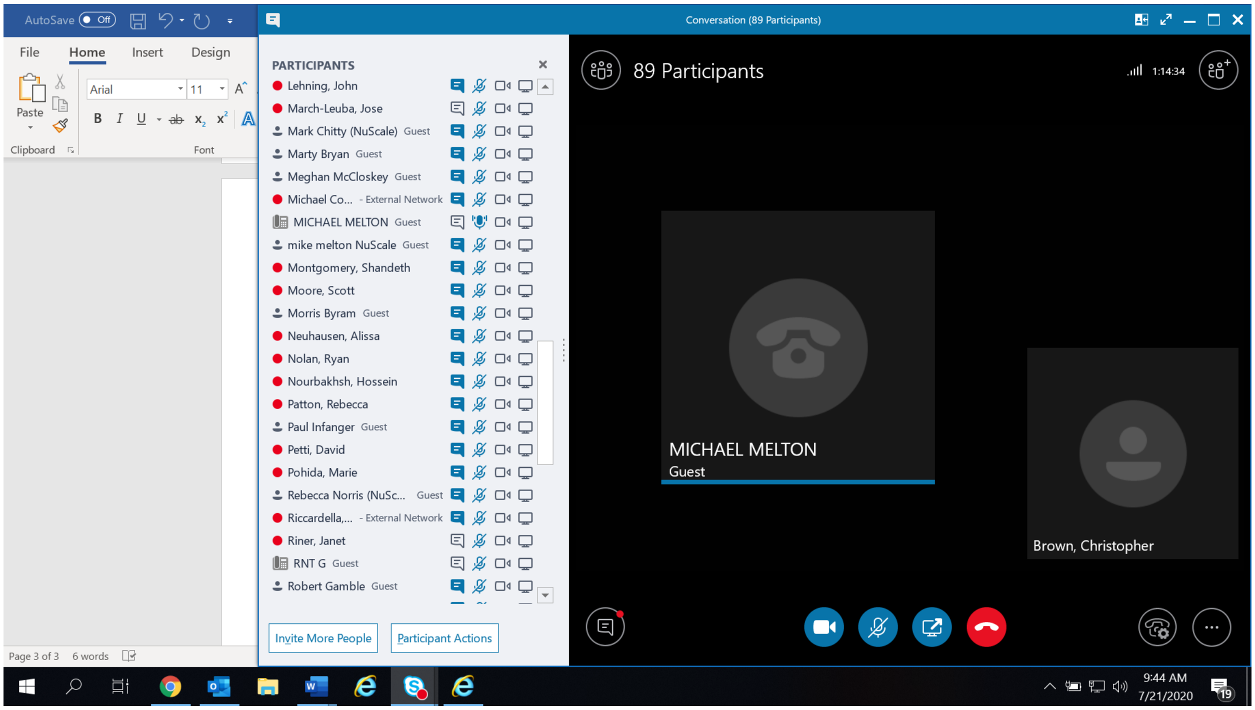
Page 3 of 3 6 words
Conversation (88 Participants)
PARTICIPANTS
Ron Ballinger Guest
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Sarah Bristol Guest
Sawant Pravin Guest
Scarbrough, Thomas
Schultz, Stephen
Taneja, Dinesh
Taylor Coddington Guest
Taylor, Robert
Tesfaye, Getachew
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Vesna Dimi Guest
Weaver, Kathy
WIDMAYER DEREK Guest
WIRELESS CALLER Guest
WIRELESS CALLER Guest
Yarsky, Peter
ZACKARY RAD Guest
Zackary Rad Guest
Invite More People
Participant Actions
88 Participants
1:15:08
Sunseri, Matthew
Brown, Christopher
9:45 AM
7/21/2020
19


Conversation (89 Participants)
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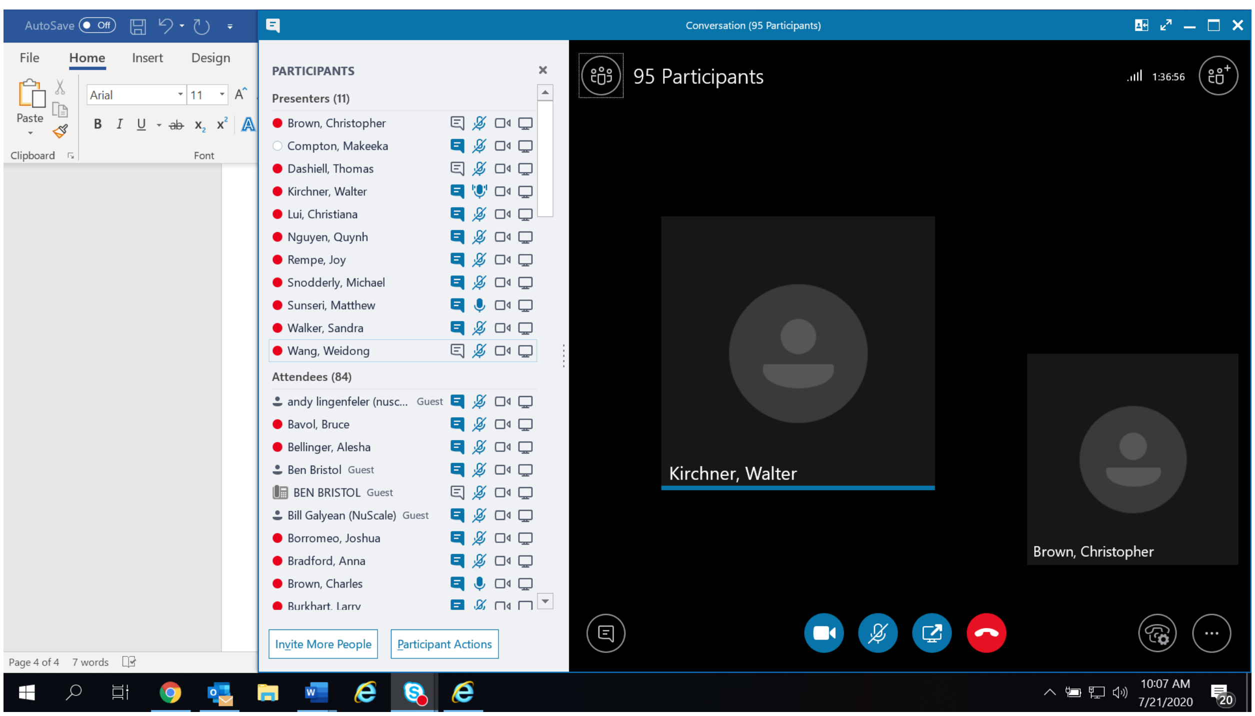
Lehning, John
March-Leuba, Jose
Mark Chitty (NuScale) Guest
Marty Bryan Guest
Meghan McCloskey Guest
Michael Co... - External Network
MICHAEL MELTON Guest
mike melton NuScale Guest
Montgomery, Shandeth
Moore, Scott
Morris Byram Guest
Neuhausen, Alissa
Nolan, Ryan
Nourbakhsh, Hossein
Patton, Rebecca
Paul Infanger Guest
Petti, David
Pohida, Marie
Rebecca Norris (NuSc... Guest
Riccardella,... - External Network
Riner, Janet
RNT G Guest
Robert Gamble Guest
Invite More People
Participant Actions
89 Participants
1:14:34
MICHAEL MELTON
Guest
Brown, Christopher
9:44 AM
7/21/2020

10:06am


Conversation (95 Participants)
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Dashiell, Thomas
Kirchner, Walter
Lui, Christiana
Nguyen, Quynh
Rempe, Joy
Snodderly, Michael
Sunseri, Matthew
Walker, Sandra
Wang, Weidong
Attendees (84)
andy lingenfeler (nusc... Guest
Bavol, Bruce
Bellinger, Alesha
Ben Bristol Guest
BEN BRISTOL Guest
Bill Galyean (NuScale) Guest
Borromeo, Joshua
Bradford, Anna
Brown, Charles
Burkhart, Larry
Invite More People
Participant Actions
95 Participants
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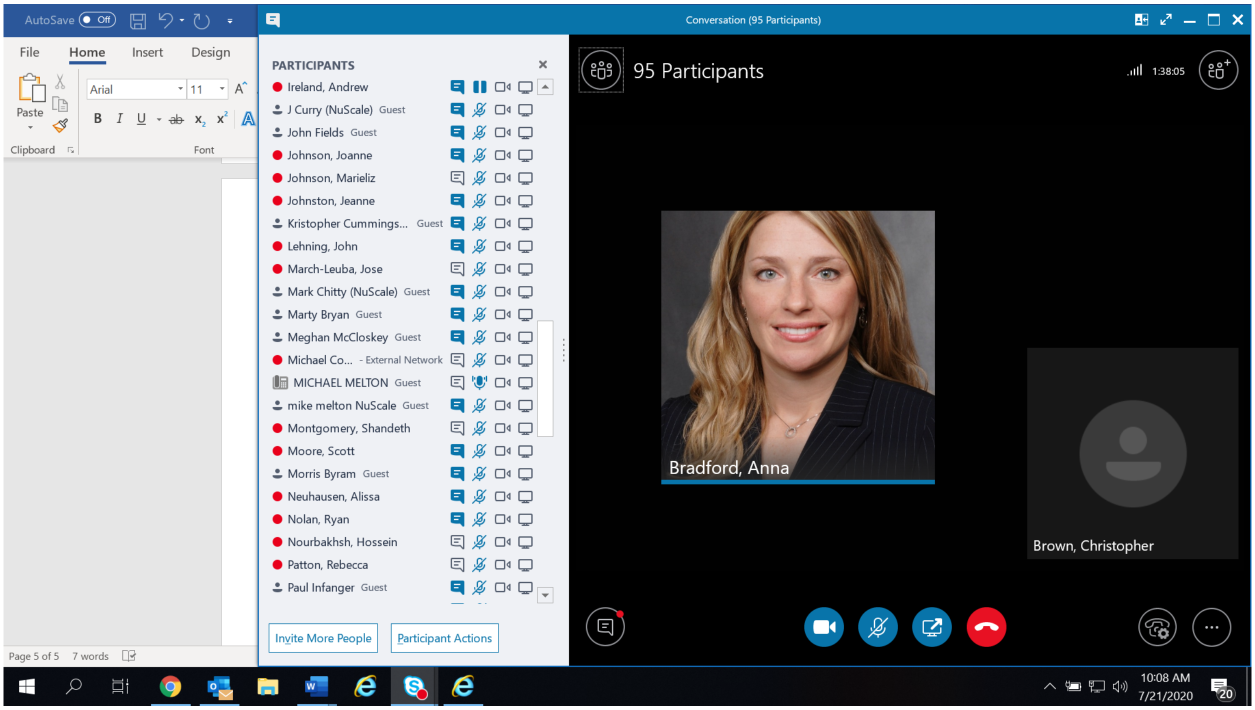
Brown, Christopher
10:07 AM
7/21/2020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Page 5 of 5 7 words
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PARTICIPANTS
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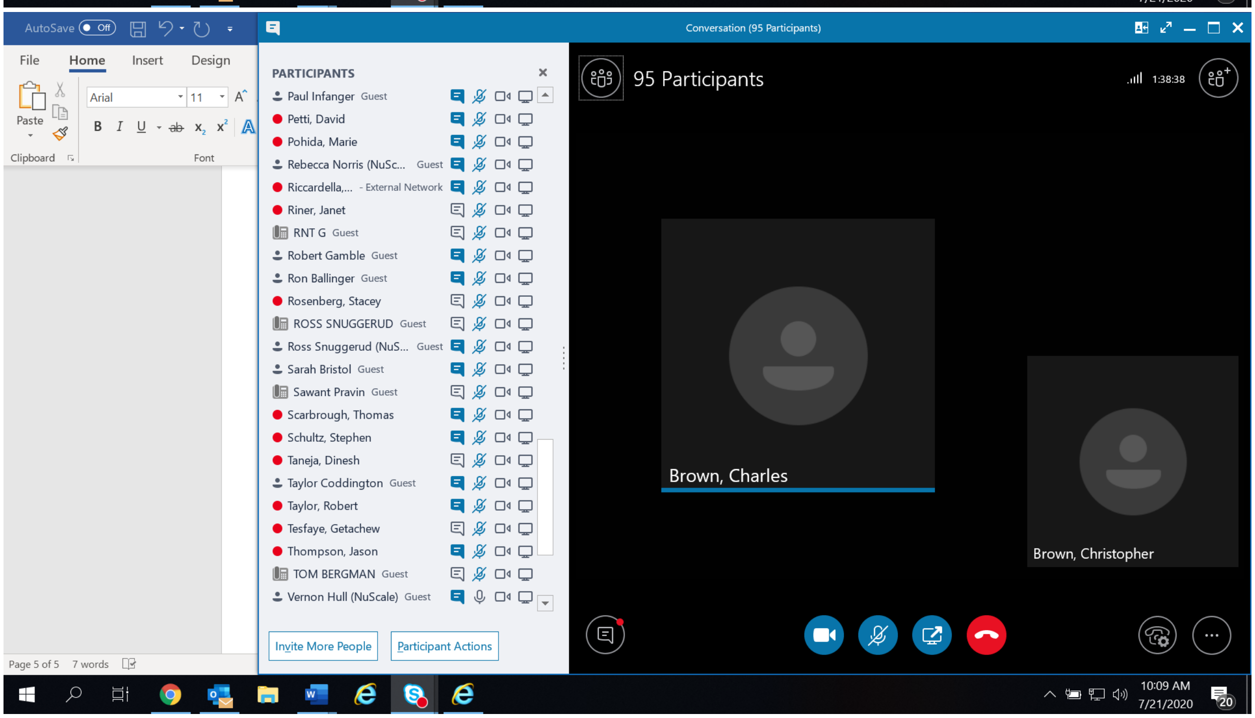
John Fields Guest
Johnson, Joanne
Johnson, Marieliz
Johnston, Jeanne
Kristopher Cummings... Guest
Lehning, John
March-Leuba, Jose
Mark Chitty (NuScale) Guest
Marty Bryan Guest
Meghan McCloskey Guest
Michael Co... - External Network
MICHAEL MELTON Guest
mike melton NuScale Guest
Montgomery, Shandeth
Moore, Scott
Morris Byram Guest
Neuhausen, Alissa
Nolan, Ryan
Nourbakhsh, Hossein
Patton, Rebecca
Paul Infanger Guest
Invite More People
Participant Actions
95 Participants
1:38:05
Bradford, Anna
Brown, Christopher
10:08 AM
7/21/2020
20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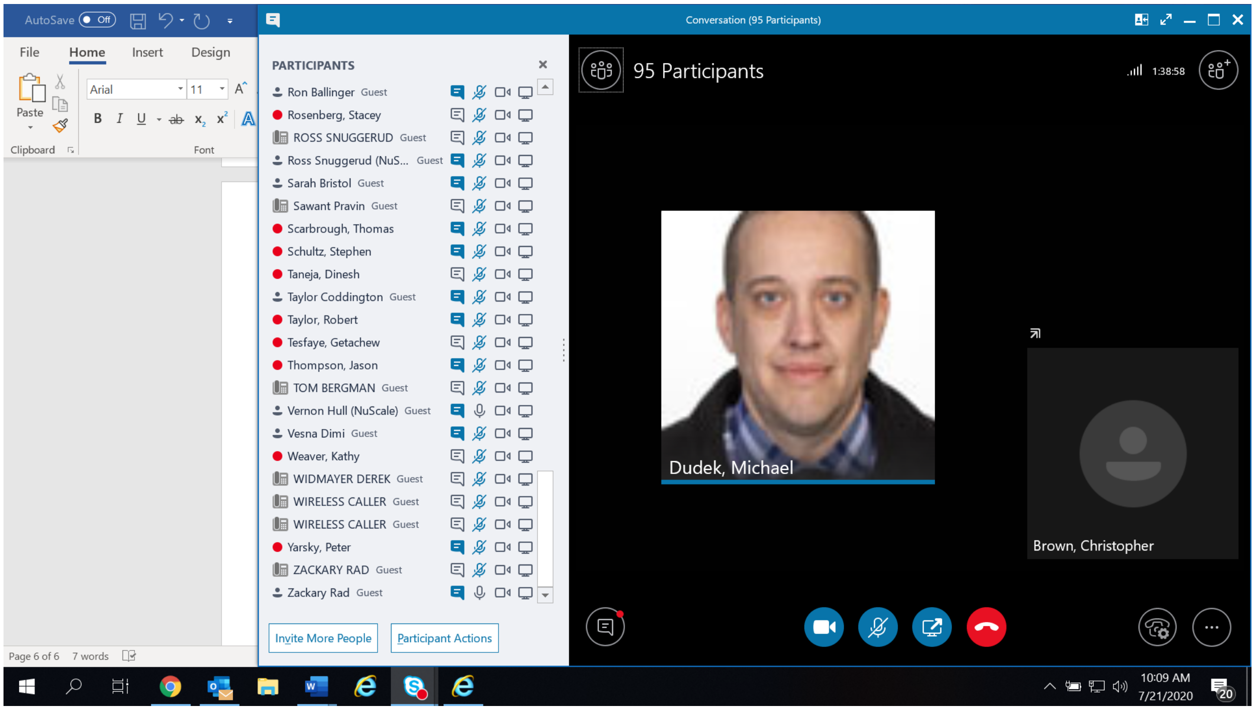
Page 5 of 5 7 words
Conversation (95 Participants)
PARTICIPANTS
Paul Infanger Guest
Petti, David
Pohida, Marie
Rebecca Norris (NuSc... Guest
Riccardella,... - External Network
Riner, Janet
RNT G Guest
Robert Gamble Guest
Ron Ballinger Guest
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Sarah Bristol Guest
Sawant Pravin Guest
Scarbrough, Thomas
Schultz, Stephen
Taneja, Dinesh
Taylor Coddington Guest
Taylor, Robert
Tesfaye, Getachew
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Invite More People
Participant Actions
95 Participants
1:38:38
Brown, Charles
Brown, Christopher
10:09 AM
7/21/2020
20



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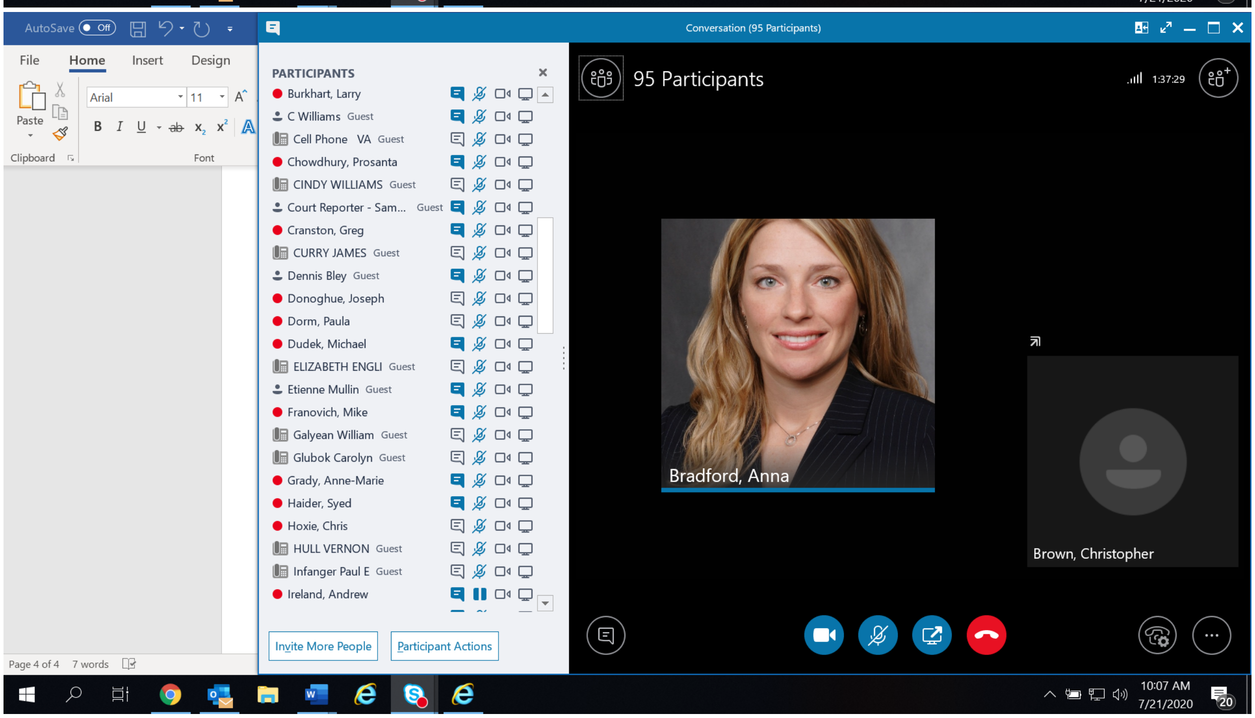
Page 6 of 6 7 words
Conversation (95 Participants)
PARTICIPANTS
Ron Ballinger Guest
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Sarah Bristol Guest
Sawant Pravin Guest
Scarbrough, Thomas
Schultz, Stephen
Taneja, Dinesh
Taylor Coddington Guest
Taylor, Robert
Tesfaye, Getachew
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Vesna Dimi Guest
Weaver, Kathy
WIDMAYER DEREK Guest
WIRELESS CALLER Guest
WIRELESS CALLER Guest
Yarsky, Peter
ZACKARY RAD Guest
Zackary Rad Guest
Invite More People
Participant Actions
95 Participants
1:38:58
Dudek, Michael
Brown, Christopher
10:09 AM
7/21/2020
20



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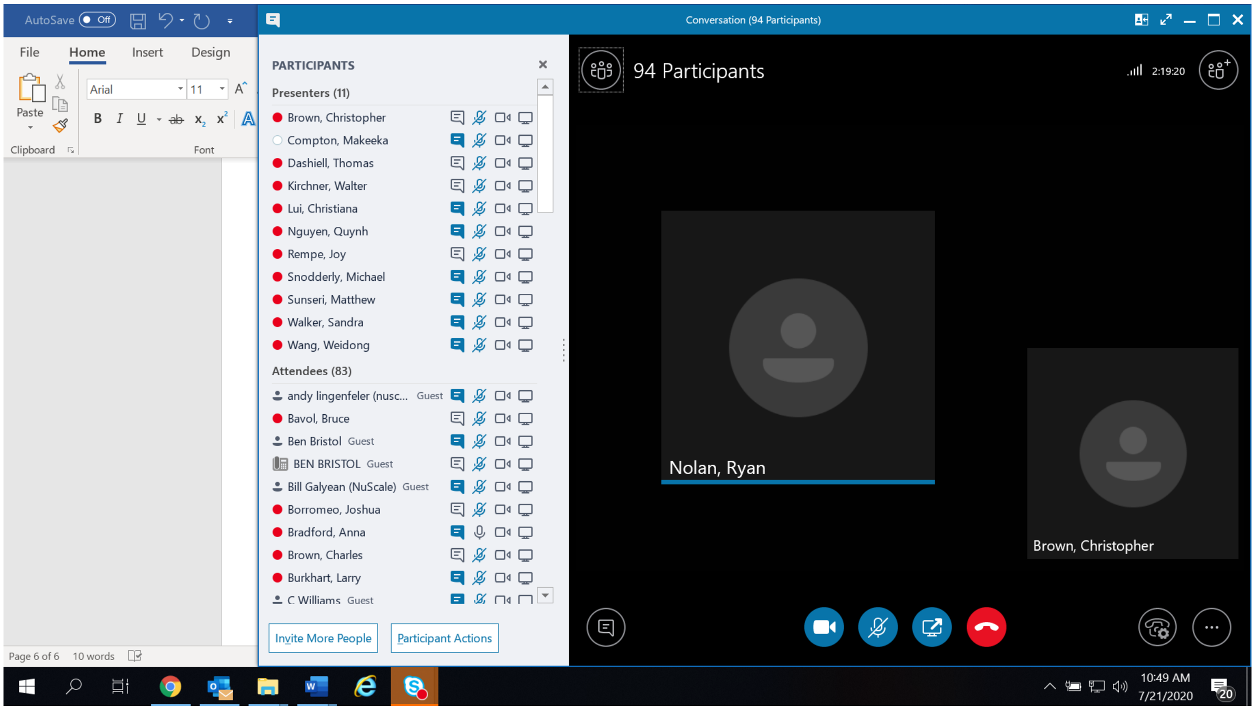
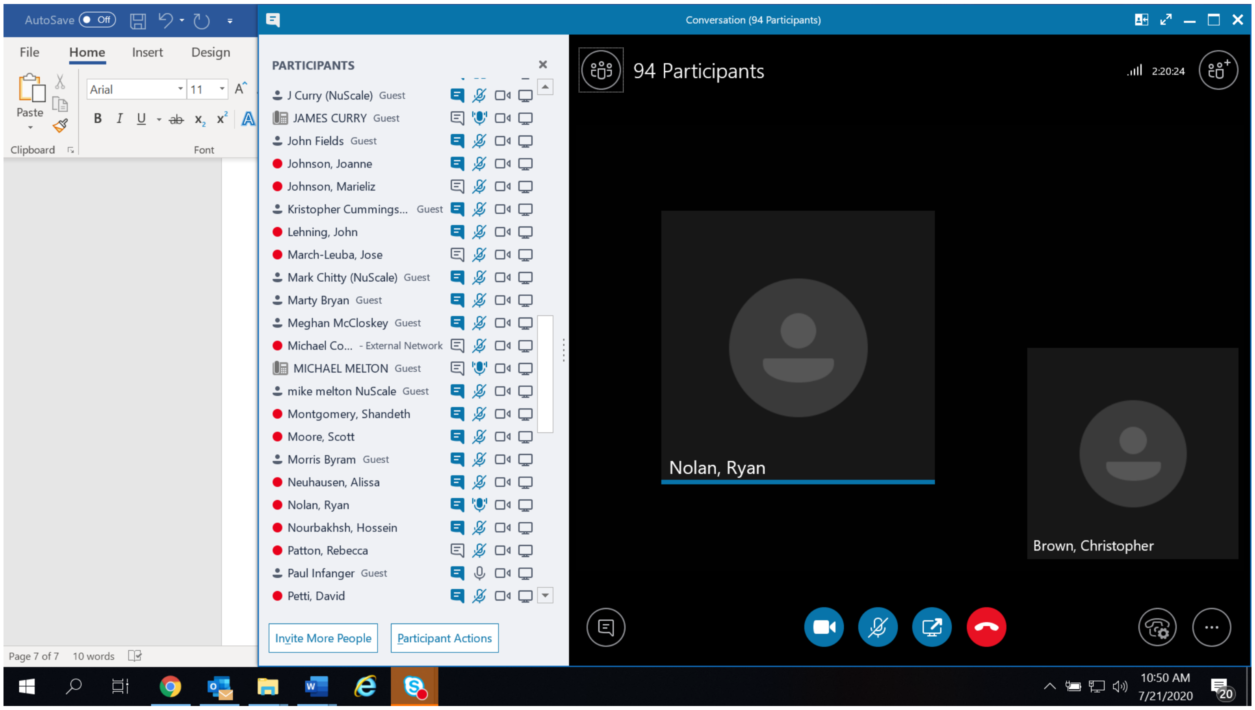
Font
Page 4 of 4 7 words
Conversation (95 Participants)
PARTICIPANTS
Burkhart, Larry
C Williams Guest
Cell Phone VA Guest
Chowdhury, Prosanta
CINDY WILLIAMS Guest
Court Reporter - Sam... Guest
Cranston, Greg
CURRY JAMES Guest
Dennis Bley Guest
Donoghue, Joseph
Dorm, Paula
Dudek, Michael
ELIZABETH ENGLI Guest
Etienne Mullin Guest
Franovich, Mike
Galyean William Guest
Glubok Carolyn Guest
Grady, Anne-Marie
Haider, Syed
Hoxie, Chris
HULL VERNON Guest
Infanger Paul E Guest
Ireland, Andrew
Invite More People
Participant Actions
95 Participants
1:37:29
Bradford, Anna
Brown, Christopher
10:07 AM
7/21/2020
20

# At 10:49 am    93 Participants

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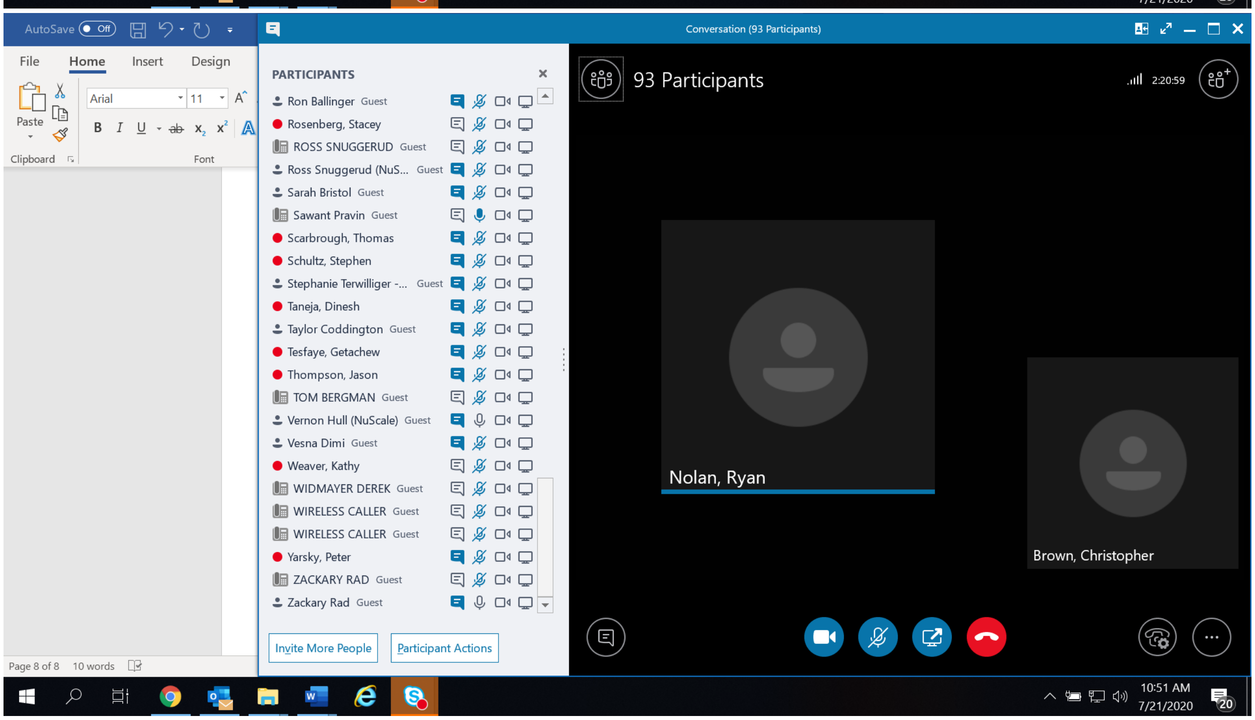
Clipboard
Font
Page 7 of 7 10 words
Conversation (94 Participants)
PARTICIPANTS
J Curry (NuScale) Guest
JAMES CURRY Guest
John Fields Guest
Johnson, Joanne
Johnson, Marieliz
Kristopher Cummings... Guest
Lehning, John
March-Leuba, Jose
Mark Chitty (NuScale) Guest
Marty Bryan Guest
Meghan McCloskey Guest
Michael Co... - External Network
MICHAEL MELTON Guest
mike melton NuScale Guest
Montgomery, Shandeth
Moore, Scott
Morris Byram Guest
Neuhausen, Alissa
Nolan, Ryan
Nourbakhsh, Hossein
Patton, Rebecca
Paul Infanger Guest
Petti, David
Invite More People
Participant Actions
94 Participants
2:20:24
Nolan, Ryan
Brown, Christopher
10:50 AM
7/21/2020
20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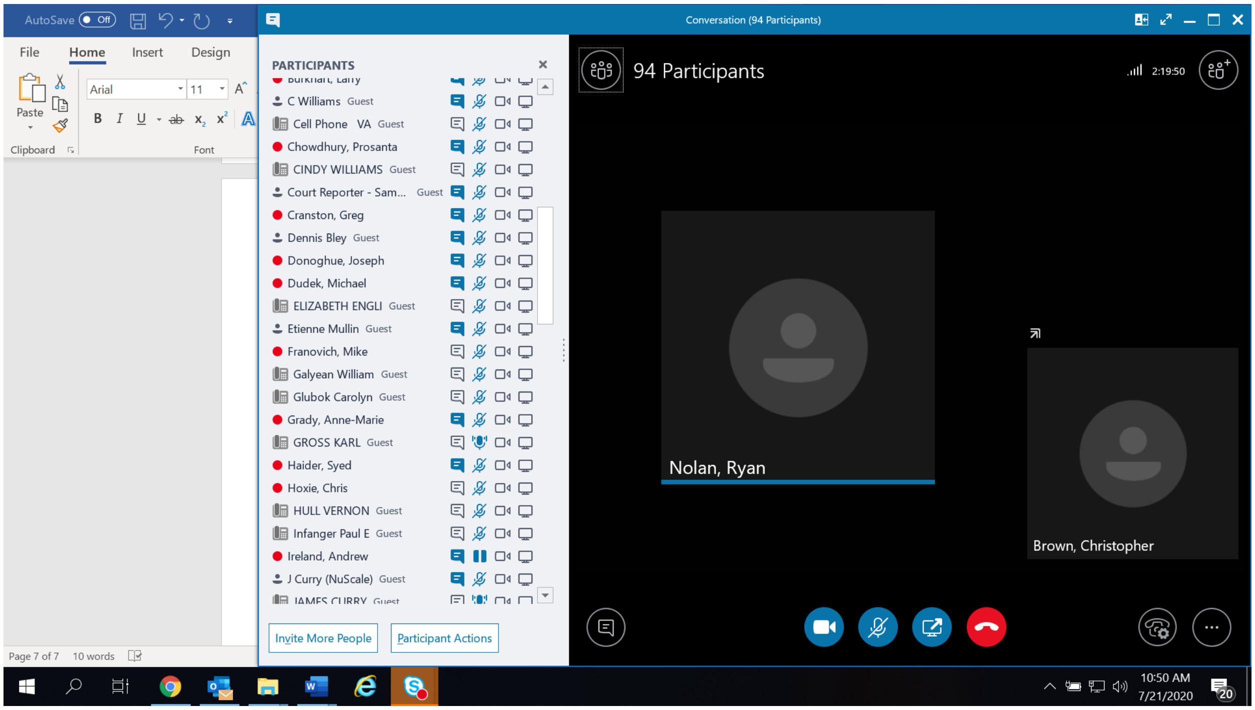
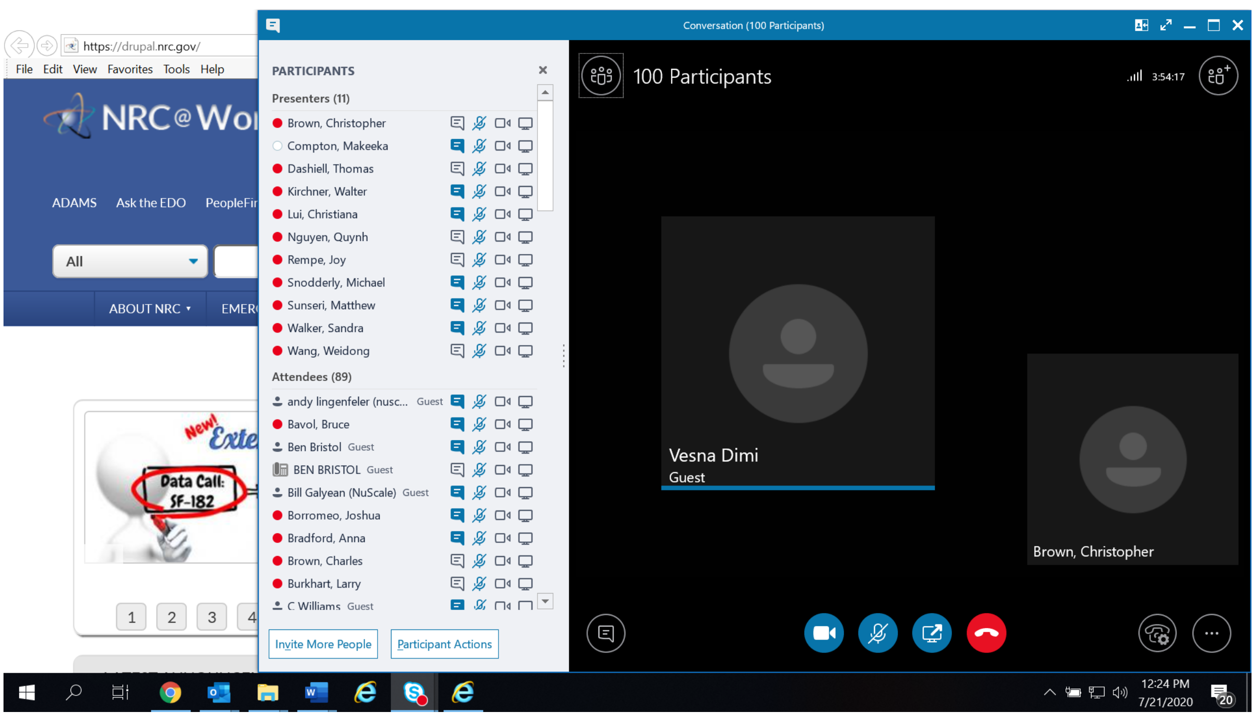
File Home Insert Design
Paste
Arial 11
Clipboard
Font
Page 8 of 8 10 words
Conversation (93 Participants)
PARTICIPANTS
Ron Ballinger Guest
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Sarah Bristol Guest
Sawant Pravin Guest
Scarbrough, Thomas
Schultz, Stephen
Stephanie Terwilliger -... Guest
Taneja, Dinesh
Taylor Coddington Guest
Tesfaye, Getachew
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Vesna Dimi Guest
Weaver, Kathy
WIDMAYER DEREK Guest
WIRELESS CALLER Guest
WIRELESS CALLER Guest
Yarsky, Peter
ZACKARY RAD Guest
Zackary Rad Guest
Invite More People
Participant Actions
93 Participants
2:20:59
Nolan, Ryan
Brown, Christopher
10:51 AM
7/21/2020
20


Conversation (94 Participants)
PARTICIPANTS
C Williams Guest
Cell Phone VA Guest
Chowdhury, Prosanta
CINDY WILLIAMS Guest
Court Reporter - Sam... Guest
Cranston, Greg
Dennis Bley Guest
Donoghue, Joseph
Dudek, Michael
ELIZABETH ENGLI Guest
Etienne Mullin Guest
Franovich, Mike
Galyean William Guest
Glubok Carolyn Guest
Grady, Anne-Marie
GROSS KARL Guest
Haider, Syed
Hoxie, Chris
HULL VERNON Guest
Infanger Paul E Guest
Ireland, Andrew
J Curry (NuScale) Guest
Invite More People
Participant Actions
94 Participants
2:19:50
Nolan, Ryan
Brown, Christopher
Page 7 of 7 10 words
10:50 AM
7/21/2020

At 12:25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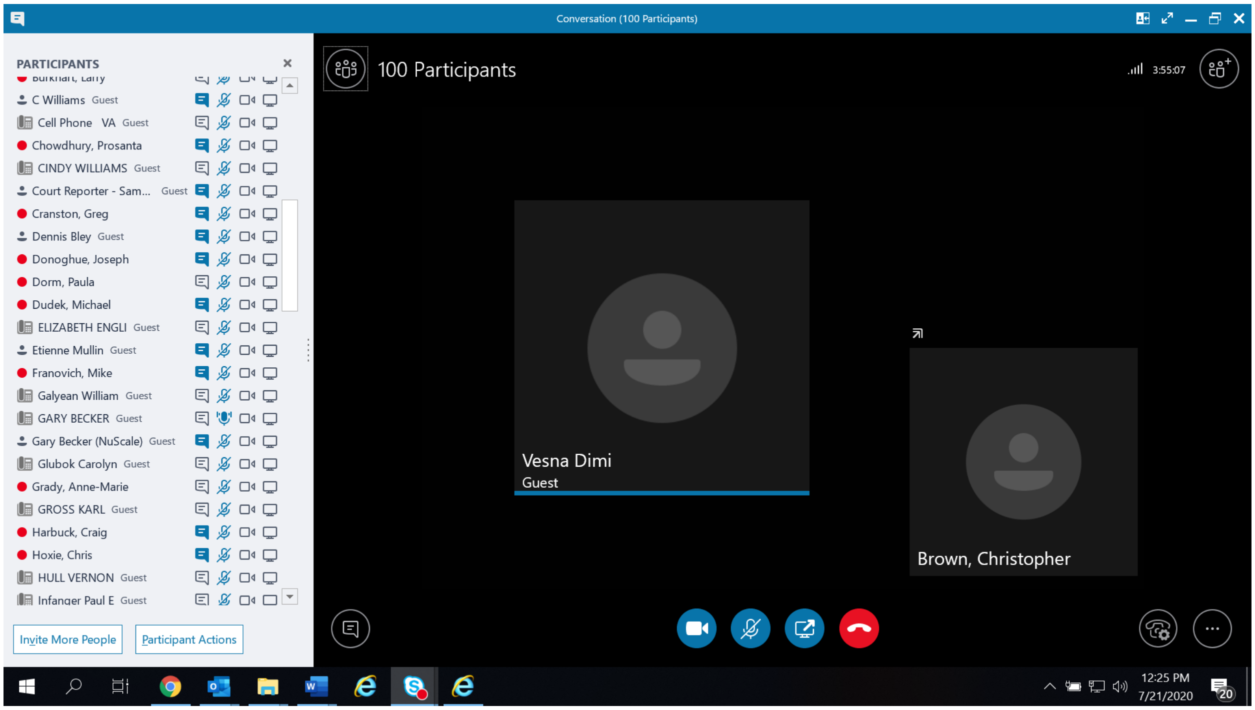
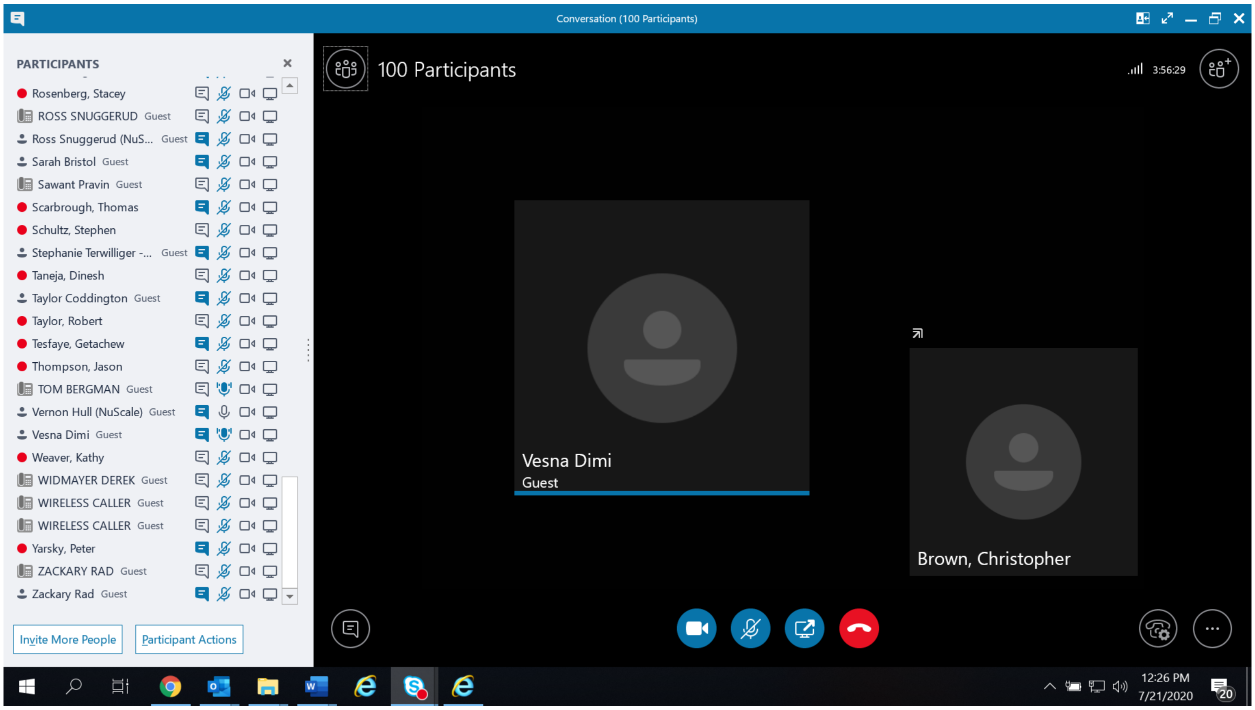
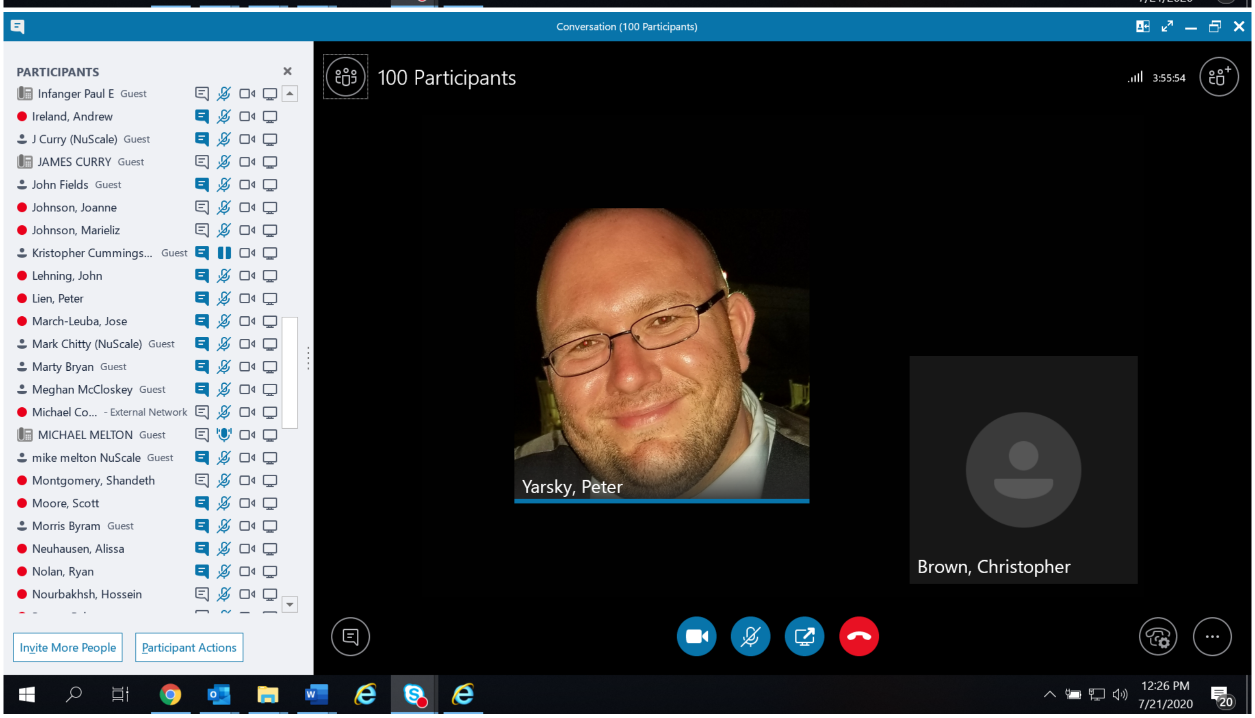
ADAMS Ask the EDO
ABOUT NRC
Data Call: SF-182
Conversation (100 Participants)
PARTICIPANTS
Presenters (11)
Brown, Christopher
Compton, Makeeka
Dashiell, Thomas
Kirchner, Walter
Lui, Christiana
Nguyen, Quynh
Rempe, Joy
Snodderly, Michael
Sunseri, Matthew
Walker, Sandra
Wang, Weidong
Attendees (89)
andy lingenfeler (nusc... Guest
Bavol, Bruce
Ben Bristol Guest
BEN BRISTOL Guest
Bill Galyean (NuScale) Guest
Borromeo, Joshua
Bradford, Anna
Brown, Charles
Burkhart, Larry
C Williams Guest
Invite More People
Participant Actions
100 Participants
3:54:17
Vesna Dimi
Guest
Brown, Christopher
12:24 PM
7/21/2020


Conversation (100 Participants)
PARTICIPANTS
C Williams Guest
Cell Phone VA Guest
Chowdhury, Prosanta
CINDY WILLIAMS Guest
Court Reporter - Sam... Guest
Cranston, Greg
Dennis Bley Guest
Donoghue, Joseph
Dorm, Paula
Dudek, Michael
ELIZABETH ENGLI Guest
Etienne Mullin Guest
Franovich, Mike
Galyean William Guest
GARY BECKER Guest
Gary Becker (NuScale) Guest
Glubok Carolyn Guest
Grady, Anne-Marie
GROSS KARL Guest
Harbuck, Craig
Hoxie, Chris
HULL VERNON Guest
Infanger Paul E Guest
Invite More People
Participant Actions
100 Participants
3:55:07
Vesna Dimi
Guest
Brown, Christopher
12:25 PM
7/21/2020
20


Conversation (100 Participants)
PARTICIPANTS
Rosenberg, Stacey
ROSS SNUGGERUD Guest
Ross Snuggerud (NuS... Guest
Sarah Bristol Guest
Sawant Pravin Guest
Scarbrough, Thomas
Schultz, Stephen
Stephanie Terwilliger -... Guest
Taneja, Dinesh
Taylor Coddington Guest
Taylor, Robert
Tesfaye, Getachew
Thompson, Jason
TOM BERGMAN Guest
Vernon Hull (NuScale) Guest
Vesna Dimi Guest
Weaver, Kathy
WIDMAYER DEREK Guest
WIRELESS CALLER Guest
WIRELESS CALLER Guest
Yarsky, Peter
ZACKARY RAD Guest
Zackary Rad Guest
Invite More People
Participant Actions
100 Participants
3:56:29
Vesna Dimi
Guest
Brown, Christopher
12:26 PM
7/21/2020
20


Conversation (100 Participants)
PARTICIPANTS
Infanger Paul E Guest
Ireland, Andrew
J Curry (NuScale) Guest
JAMES CURRY Guest
John Fields Guest
Johnson, Joanne
Johnson, Marieliz
Kristopher Cummings... Guest
Lehning, John
Lien, Peter
March-Leuba, Jose
Mark Chitty (NuScale) Guest
Marty Bryan Guest
Meghan McCloskey Guest
Michael Co... - External Network
MICHAEL MELTON Guest
mike melton NuScale Guest
Montgomery, Shandeth
Moore, Scott
Morris Byram Guest
Neuhausen, Alissa
Nolan, Ryan
Nourbakhsh, Hossein
Invite More People
Participant Actions
100 Participants
3:55:54
Yarsky, Peter
Brown, Christopher
12:26 PM
7/21/2020
20