Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards:
NuScale Subcommittee

Docket Number: N/A

Location: Rockville, MD

Date: January 23, 2018

Work Order No.: NRC-3483 Pages 1-199

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

DISCLAIMER

UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

NUSCALE SUBCOMMITTEE

+ + + + +

TUESDAY

JANUARY 23, 2018

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 1:00 p.m., Michael Corradini, Chairman, presiding.

COMMITTEE MEMBERS:

MICHAEL L. CORRADINI, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member *

GORDON R. SKILLMAN, Member

JOHN W. STETKAR, Member

MATTHEW SUNSERI, Member

ACRS CONSULTANT:

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

MICHAEL SNODDERLY

ALSO PRESENT:

CLINT ASHLEY, NRO

BRUCE BAVOL, NRO

GARY BECKER, NuScale

THOMAS BERGMAN, NuScale

ANDREW BIELEN, RES

DERICK BOTHA, NuScale

BEN BRISTOL, NuScale

ALLYSON CALLAWAY, NuScale

NAN CHIEN, NRO

GREG CRANSTON, NRO

TIM DRZEWIECKI, NRO

SARAH FIELDS *

ROBERT GAMBE, NuScale

DARRELL GARDNER, NuScale

ANNE-MARIE GRADY, NRO

REBECCA KARAS, NRO

SAMUEL LEE, NRO

JOHN MONNINGER, NRO

WILLIAM RECKLEY, NRO

JEFFREY SCHMIDT, NRO

ANGELO STUBBS, NRO

MATT THOMAS, NRO

BOYCE TRAVIS, NRO

* Present via telephone

C O N T E N T S

P R O C E E D I N G S

12:58 p.m.

CHAIR CORRADINI: Okay. The meeting will come to order. This is a meeting of the ACRS' NuScale Subcommittee.

My name is Mike Corradini, Chairman of the Subcommittee. Members in attendance today are Ron Ballinger, Dennis Bley, Gordon Skillman, soon to be Dana Powers, Matt Sunseri, John Stetkar, soon to be Jose March-Leuba, and Walt Kirchner.

And our consultant, Steve Schultz. Oh, and Charlie Brown and Dennis Bley, they're coming in all over the place. Dimitrijevic and Harold Rey is on the line.

I can't keep them all as to where they are in the world. Mike Snodderly is the Designated Federal Official for this meeting.

The purpose of today's meeting is to review the criteria the staff will use to determine whether NuScale's request for Exemption from General Design Criterion 27, combined reactivity control systems capability is acceptable.

Today we have members of the NRC staff and NuScale Power to brief the Subcommittee. The ACRS was established by statute and governed by the Federal

Advisory Committee Act.

That means the Committee can only speak through its published letter reports. We hold meetings to gather information such as this to support our deliberations.

But, I'll mention here, since we always somehow come -- that all the members' comments are the member's personal comments, just trying to get information.

Interested parties who wish to provide comments can contact our office regarding time after the meeting announcement is published in the Federal Register.

That said, we set aside ten minutes for extemporaneous comments from the Members and the public attending and listening in on these. Written comments are also welcome.

The ACRS position on the U.S. NRC's public website provides our charter, bylaws, letter reports, full transcripts of all full and subcommittee meetings, including slides presented here.

The rules for participation in today's meeting were announced in the Federal Register Notice of December 28, 2017. The meeting was announced as an open and closed meeting.

And if necessary we'll, after taking our open session and getting comments from the general public, we'll go to closed session to pick up any particulars.

I'll just turn to the NuScale staff. If we're getting into something that requires to go to closed session, alert us. And we'll hold off and come back to it.

No written statement or request for making an oral statement to the subcommittee has been received from the public concerning this meeting.

A transcript of the meeting is being kept. And will be made available as stated in the Federal Register Notice. Therefore we request that participants in this meeting use the microphones located throughout the meeting room when addressing the subcommittee.

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

And we have a bridge line established for the public to listen to the meeting. To minimize disturbances, this public line will be kept in a listen in only mode.

And to avoid disturbance, I request that

all members put their electronic devices like cell phones and other things, in the off or the noise free mode.

We will now proceed with the meeting. And I'll call on Becky Karas of the Office of New Reactors to begin today's presentation. Becky?

MS. KARAS: Thanks. I'm Becky Karas. I'm the Branch Chief for the Reactor Systems Branch.

I just wanted to say, I appreciate the committee's time today in reviewing the policy paper regarding the NuScale request for an exemption from GDC 27.

The staff views this as an important issue. And that's one of the reasons for early engagement with the ACRS on the acceptance criteria that we plan to use to evaluate a return to power event resulting from a design basis event, an AOO, or an accident, with a failure of one control element assembly to insert.

I note this will be the first of a kind criteria. There's other designs that have been licensed to date achieve sub-criticality over the long term.

There's some precedent for a short term return to criticality for PWRs under certain conditions with main steam line break. But they do achieve

sub-criticality within a few hours of that event.

So, I note that we're very early in the technical review. And we're currently auditing some of the calculations.

So, we don't plan on a detailed technical discussion of the analytical results. But we do look forward to a productive discussion with the committee on this criteria.

CHAIR CORRADINI: Okay. Thank you very much. And I will turn to Darrell to lead us off for NuScale.

I think your group is first up.

MR. GARDNER: Yes, sir. First of all, --

CHAIR CORRADINI: You need a green light on. There you go.

MR. GARDNER: Thank you Mr. Chairman. My name is Darrell Gardner. I'm Licensing Project Manager with NuScale.

Thank you for the opportunity to present before the subcommittee today. Talk about the background of our design and consequence analysis in support of the staff's paper that was just mentioned.

We have three presenters today. I'll let them introduce themselves as they present.

And we'll get started. Derick.

MR. BOTHA: Thank you. My name is Derick Botha. Just a little bit of background, I've a -- my initial technical background, I was a mechanical studies and mechanical engineer is my undergrad.

Also, I've got a Master's in thermal systems design. I've got about seven years obviously that's been doing safe analysis and thermal systems analysis.

I then transitioned into doing licensing work. So I've done that for about ten years, the last ten years.

And more recently I've now transitioned into our Office of Technology Department. I'm now the Innovation Manager at NuScale.

I've spent about seven years at NuScale. And prior to that I worked in South Africa on the PBMR project. So that's the -- a really big project that's a high frequent gas reactor.

So, thank you for listening to our presentation today. I'm not going to spend too much time on this.

But it gives you an idea of what work we'll be covering. So if you can go to the next slide.

So, just for background, so if you look at the NuScale design, we elected to use reactivity

control systems that's well matched with the design and the design characteristics.

Such that if you have power available or if you were to lose power, in terms of safety capability, we've got rods. We insert the rods and that puts the reactor in a safe condition.

And that's irrespective of the event that you're looking at. So, the event tree, the reactor from a reactivity control perspective is handled the same for all our events.

We also have a non-safe load chemical binding control system. But that's not the system that we're aligned in terms of design basis events and our primary ports of insuring safety.

So, another characteristic of the NuScale design is it's a pretty small core. And therefore each of the control rods has got a higher relative worth.

So therefore if you have one of your control rods that's stuck, there's a significant larger amount of reactivity that you're not having to insert in your reactor.

And as a result, there is a low probability for the line to turn to power event. And that's what we're going to be addressing today.

We've looked at that characteristic.

We've looked at the design extensively in terms of our reactor control systems and the options we have.

And specifically we also looked at the regulatory requirements. And to address that we've submitted a white paper to the staff and there's a reference on the presentation.

And that covers also the specifically the compliance with GDC 26 and 27. But also the -- NuScale's interpretation of intent of those GDCs.

And the two functions based on our interpretation that those GDCs address is first the protection function. That's rapid power reduction and rapid shutdown to protect the fuel.

And then second from that is the shutdown function. And that's the capability to hold the core subcritical under cold conditions, or long term shutdown if you will.

Just from the staff position with respect to these two GDCs is that we require an exemption from GDC 27. And as Becky points out, that is because of the precedence.

So if you look at the precedent of previous reactors, they're able to with the stack rod, maintain a shutdown condition in the long term.

MEMBER BLEY: What -- maybe this is a

question better asked of the staff later, and I will.

But, since you're the ones asking for an exemption to GDC 27, I've read your discussions. And your argument is unique, the plain language of the GDC.

What specific aspect of the GDC are you requesting an exemption to? It seems that you're requesting an exemption to some staff guidance on this issue.

MR. BOTHA: Yeah.

MEMBER BLEY: But you're really -- not really asking for an exemption from the GDC. Which troubles me.

MR. BOTHA: Yeah. So, I think that from NuScale's perspective that the answer I recall from the exemption that we submitted as part of the application is based on this precedent.

So the interpretation for the GDC is well, you would require, the GDC would require shutdown. Even though that's not in the literal language.

So, based on that interpretation, we're requesting the exemption.

CHAIR CORRADINI: So, can I pursue Dennis' question. And I'm sure the staff has an answer.

So, from your perspective you don't think you need an exemption? But you've been instructed by

the staff that -- to proceed that you should request an exemption?

MEMBER BLEY: No. That --

CHAIR CORRADINI: Maybe that's brutally blunt. But that's the --

MEMBER BLEY: But that's the question.

CHAIR CORRADINI: Sure.

MR. BOTHA: So that's the position we took in the white paper. However, the white paper was submitted before we submitted our application.

So, we've had negotiations with the staff and decided to embark on the process of submitting our application with an exemption.

And there are additional comments from --

MR. SCHULTZ: Are you going to present the language that you provided for the exemption request? That you provided in your application, now?

MR. BOTHA: Not as part of this presentation. No.

MR. SCHULTZ: Okay.

CHAIR CORRADINI: It's part of the staff's presentation.

MR. SCHULTZ: I know it's there. Maybe we can have a dialog at that point in time when we talk about that particular language.

CHAIR CORRADINI: Yeah. I think somebody from your group wants to say something.

MR. BECKER: Yes. Thank you.

CHAIR CORRADINI: You have to identify yourself.

MR. BECKER: Gary Becker, Regulatory First Counsel for NuScale Power. I just wanted to add to the conversation on the exemption.

That it's our position that we took in the white paper that we comply with the requirements of GDC 27 has not changed. We stand by that assessment.

However, we submitted an exemption request that GDC.

MEMBER SKILLMAN: Derick, let me ask this question, please. In her opening comment, Becky mentioned that there is precedent for this.

And I'm presuming that NuScale is saying yeah, yeah, there's precedent, we can do this.

Can you explain the comparison between a steam line break and the reactivity addition that comes as a consequence of that steam line break. And why that is an appropriate precedent that's basically saying, I don't want to comply with General Design Criteria 26 and 27.

I will just say up front, I see those as

two entirely different approaches. So, I'd like to know why a steam line break is a precedent for what you are requesting.

MR. BOTHA: So just to clarify, if you said entirely different approaches, are you referring to the tenant?

MEMBER SKILLMAN: The main steam line break. You've got a huge cooling reaction that will drive moderator temperature coefficient to drive the core positive, to drive reactivity.

I understand that.

MR. BOTHA: Um-hum.

MEMBER SKILLMAN: That's not what you're talking about --

MR. BOTHA: Sure.

MEMBER SKILLMAN: In the basis of your exemption request. So, I -- what I'm doing in my own mind is rejecting the notion that there's a precedent.

MR. BOTHA: I understand.

MEMBER SKILLMAN: I don't think that there's a precedent based on the steam line break argument. There maybe another one.

But that one doesn't fit.

MR. BOTHA: So, I think there's two answers to your question. The first is the -- just that the

literal compliance question.

And that's got to do with the wording and what they require on face value and intent. And we don't intend to address that too much today. That's not really the purpose of the presentation.

I think what you're alluding to is the second aspect. And that's really the technical and the safety questions associated withe the underlying functions that you address with the GDC.

So, I think those are two very different events. And to today's presentation, the first off presentation is to give you the like context so you can understand the events we're talking about and the context of our design.

So, I would agree with that statement.

MEMBER SKILLMAN: Thank you.

MR. BOTHA: Well, thank you. I think the other point to make here, just based on some of the discussion we had is, well this presentation, we're really going to focus on context and explaining the scenarios, the conditions under which you could have a return to power.

But we're going to be focusing on the best estimate or what we realistically expect to occur. We're going to focus far less on the relation that occurs

here, the Chapter 15 analysis that is in the application.

And that's a concerted assessment. So, that's just for context. As you go through the slides, when we start talking about the event and when it can occur, that's really based on the nominal conditions and what we expect to happen.

Before we get into that, just some additional background on our design. So, I'm going to go over the two passive safe related heat removal systems that we have in the NuScale design.

And the first one I'm going to cover is the decay heat removal system. The way we actuate the system, so that's a diagram showing the reactor module with you'll see two condensers off on the sides.

And you'll see the steam generator in the module. On the top of that module you'll see the full feed and steam isolation valves.

There's more valves then that. But that's depicted on this diagram. So, to actuate the system you would actuate your -- you would close your feed and steam isolation valves.

And then you would open the DHR valves that sit in that loop that connects the steam generator and the condensers on the side. That's depicted there on

the sides of the containment vessel.

MEMBER MARCH-LEUBA: Excuse me Derick. Can you get the mouse and point at when you're talking? And as it's mentioned.

MR. BOTHA: Sure. So, those are the four feed and steam isolation valves that would close. This is the steam generator.

What's important to recognize is our secondary side is on the inside of the tubes. That's different from a traditional PWR.

And these are the DHRS condensers that sit on the side. And so you can see a loop that's connecting these two heat exchanges.

And those are the valves that would open to allow the water inside of that system that's normally there while you're removing heat, to start flowing.

And at that juncture, you'll remove heat by boiling inside of the steam generator and condensation inside of the DHRS and heat exchangers which sits into the reactor.

CHAIR CORRADINI: And you only need one of the two heat exchangers to function?

MR. BOTHA: That's correct. So we've got two independent drains. And they each have two valves.

MEMBER STETKAR: Derick, you said you're

going to emphasize best estimate analysis. Do our best estimate analysis account for both of them operating?

MR. BOTHA: After.

MEMBER STETKAR: That's a yes or a no.

(Laughter)

MEMBER STETKAR: I want to know yes or no. Honestly, I want to know yes or no. Do they? Or do they not?

MR. BOTHA: That would be yes and no.

MEMBER STETKAR: No, no. You said you're going to emphasize best estimate analysis.

MR. BOTHA: I mean -- yes. Yes.

MEMBER STETKAR: So that we can understand the technical basis for your assertions.

MR. BOTHA: But yes.

MEMBER STETKAR: So do your best estimate analysis account for both of them operating?

MR. BOTHA: The answer would be yes. And the reason is you cool down faster when you have both operating.

MEMBER STETKAR: That's correct. That's why I asked the question.

MR. BOTHA: Okay. Thank you. Thank you. Next one Allyson.

So I'll use the mouse again for this one.

And so this is our ECCS system. And this system ensures that we can provide adequate core cooling without injection.

So which is different from a traditional ECCS system where you would have to add water. So how the system functions, is when you open the ECCS valves, so there's two main valves at the -- sorry, three arrangement valves.

Not supposed to be -- three main valves at the top of the reactor pressure vessel. And two recirculation valves at the bottom.

And once you've opened those valves so depending on the size break you may have, you'll have a different pressure response. But essentially what happens, once you depressurize you now enable a stable cooling loop where you're venting steam through the vent valves.

That steam condenses on the inside of the containment. And the heat is removed via -- through the containment wall to the reactor pool.

And then your level inside containment will then exceed your level inside the reactor pressure vessel, which would drive liquid back into the core.

So that would be your ECCS function.

MEMBER KIRCHNER: What's the sequence for

deciding when to go from your passive operation on your proceeding slide to the ECCS system?

MR. BOTHA: So that depends on the event. So our first however if you do have power, and if you -- in that case you would actuate the system.

And now I'm talking about if you would have AC power. Then you would actuate the system.

MEMBER KIRCHNER: The system being the decay heat removal system?

MR. BOTHA: Well, your --

MEMBER KIRCHNER: Sorry, risk -- passive decay heat.

MR. BOTHA: Yeah. Your ECCS, you would -- yeah, you would be using the DHRS normally if it was a loss of feed water event for example.

MEMBER KIRCHNER: Um-hum.

MR. BOTHA: But if you have a breach in your system, say if you have a CVCS line break inside containment for example, then the system would be depressurizing.

And then at some point you would actuate your valves to go to ECCS. If you do not have AC power -- well, before I get to that, if you do have AC power, as part of your normal shutdown sequence, at some stage you open the valves anyway.

Because when you got to refueling, that's --

MEMBER KIRCHNER: You have depressurized.

MR. BOTHA: And flood the containment. Now if you don't have AC power, we have limited capacity on our batteries.

And we'd like to keep that operating as long as possible. So, after 24 hours we would take the load off, or reduce the load off the batteries.

And one of the things we'll do is open the valves after 24 hours.

MEMBER KIRCHNER: Um-hum.

MR. BOTHA: Now, if you don't have any power at all, then you would open them sooner. They have a means for -- for not opening in high pressure, but opening at reduced pressure.

But that would be in less then 24 hours. That's if you have no power at all.

So, I'll proceed to the next slide. So that was a bit of background on our design.

Now, as I mentioned, the two functions that's addressed by those two GDCs, the first is your protection function. And your -- and then secondly your shutdown function.

So with regards to the protection

functions, or protecting your fuel, our control rods provide higher -- highly reliable means to rapidly shut down the reactor for all events.

And that's even if you were to assume a stack rod. So, we sufficiently fulfill the protection function with our secondary control rods.

Now if you look at the shutdown function, to characterize that, and as I mentioned, this is under nominal conditions.

So you would -- so to give you a sense of when you would see this low probably event, essentially you would remain shut down after you've inserted your control rods.

Indefinitely if one of them has inserted. So if you've got all of them in, you'll stay shut down indefinitely.

If you're in the first 70 percent of your fuel cycle, you'll stay shut down even if you have a stack rod. And then if you're -- if you're going through a normal fuel cycle and you do have a stack rod and you're at the end of your cycle, then what happens if you have a stack rod is you have to get down to very low power levels.

Because if you have -- at power levels above 100 kilowatts, you generate voiding, which adds

additional negative reactivity.

So you've got to get the power down to less then 100 kilowatts to reduce the voiding. So that you have this return to power condition.

So, it's a really low power, a low probability condition. It's also a low power condition because you have to be below those powers to stay -- if we can have a return to power.

CHAIR CORRADINI: So, again, we're talking about criteria. So, I'm just going to remind myself and everybody else, we want to stay on discipline.

We're going to love to talk about your example.

MR. BOTHA: Sure.

CHAIR CORRADINI: You skipped the middle one. I don't understand the middle one. Indefinitely with rods stuck out during first 70 percent of equilibrium fuel cycle.

Can you explain that, please?

MR. BOTHA: So, as you go through your two-year cycle, after you've reloaded your care, for 70 percent of that time, you'll start initially with a high boron concentration.

And as you go through your fuel cycle, you dilute your boron.

CHAIR CORRADINI: Okay.

MR. BOTHA: So if you get to the last 30 percent then there's less boron on in the system to concentrate as before.

MEMBER STETKAR: What determines that 100 kilowatts?

MR. BOTHA: So, Allyson, you want to --

MEMBER STETKAR: And if we're -- if we get into proprietary stuff --

CHAIR CORRADINI: We'll wait. We can wait, sure.

MR. BRISTOL: This is Ben Bristol. We'll get -- I'm going to be describing this particular condition in a couple more slides.

MEMBER STETKAR: Great. Okay.

MR. BRISTOL: Effectively it's the power level that results in insufficient voiding in our ECCS mode.

MEMBER STETKAR: Yeah. Okay. I'll wait for a couple of sentences.

MR. BOTHA: Thanks for the question.

MEMBER SKILLMAN: I would like to ask Derick another question. I was impressed that the emphasis that you placed on the third bullet there, would have to get below 100 kilowatts.

Is that set wording that you used Derick, have to get there, sounds to me like a sense of urgency.

MR. BOTHA: No. So --

MEMBER SKILLMAN: Would you maybe rephrase or explain what you meant, please?

MR. BOTHA: So typically if you -- and I'm going to get to this in the next bullet. If you go through a normal fuel cycle, you're going to have decay heat that's been built up.

So it takes a very long time or that decay heat to reduce to less then 100 kilowatts. So I'm essentially just saying, you wouldn't get there before you've waited a very long time for decay heat to be -- to decay away to lower values.

And that's for a typical fuel cycle, that's going to be more then 30 days. And we have a footnote there to indicate that that's going to be about 100 days to get there for a typical fuel cycle if you're in the end of cycle.

So it's not that you're trying to get to 100 kilowatts. That's just the conditions under which you would see a return to power.

If you had a higher decay heat values, you wouldn't see a return to power.

MEMBER SKILLMAN: So explain the

difference between the 100 days that you have on that bullet and the -- the 30 days you have on that bullet and the 100 days that you just described.

MR. BOTHA: So, the more then -- it's -- the 30 days is just a minimum. The 100 days is when you go and actually look at the tables for a typical decay heat curve when you get below 100.

MEMBER SKILLMAN: Below 100 kilowatts.

MR. BOTHA: That's right. Yeah.

MEMBER SKILLMAN: And the answer is, it's a long time. It's three or four months.

MR. BOTHA: That's right.

CHAIR CORRADINI: So, Dick was going down a path. If you don't mind, I just want to finish the path.

I'm -- now I thought I understood the third bullet. And now I don't. So, I'm in a condition. Let me just lay out the condition.

I'm in a condition where I tried scrambling the reactor. One rod is -- one rod bank, or one rod control assembly --

MR. BOTHA: The seal control.

CHAIR CORRADINI: seal assembly has struck out.

MR. BOTHA: That's right.

CHAIR CORRADINI: I've lost power. So, I don't have AC power to drive the CVCS to insert additional boron.

MR. BOTHA: That's correct.

CHAIR CORRADINI: And I would have enough boiling, enough void production that I'm not going to be critical for which time? That's where I get confused.

That's what -- I think where Dick was going. Or unless I misunderstood your question. Am I down the right path though what's happening here?

Because I --

MR. BOTHA: Yeah.

CHAIR CORRADINI: I get down in these conditions, but I've lost almost everything. But because of the natural circulation characteristic of the reactor, it's going to have a little bit of bubbles generated.

MR. BOTHA: Yes.

CHAIR CORRADINI: And that's good enough to keep you sub-critical for a long time.

MR. BOTHA: That's right.

CHAIR CORRADINI: So, do I have that right?

MR. BOTHA: That's correct.

CHAIR CORRADINI: Okay.

MR. BOTHA: So, the only way you can have these events is exactly like you described. Is you have to have a stack rod. You have to be at end of cycle.

You have to have no AC power. You also have to not only be at end of cycle, you would have had to have a period when you were shut down for a long time.

And then at a restart in the cycle such that you now were in the cycle, had low boron and had low decay heat. So that's the conditions that --

CHAIR CORRADINI: Say the last part again, please. I'm sorry.

MR. BOTHA: You would have to shut -- you would have to -- for more then 70 percent of your cycle, shut down the reactor for a long time for decay heat to subside.

Then restart the reactor. And then within a -- for the first of two months, or a month or two of reactor operation, you would have to have these conditions occur.

Because if you go through a normal fuel cycle, you would have enough decay heat present that you wouldn't get to a return to power.

So again, this is under nominal conditions.

MR. SCHULTZ: So when you say you have to be shut down near the end of cycle for a long time.

MR. BOTHA: That's right.

MR. SCHULTZ: How long is that?

MR. BOTHA: That's more then three months. Because that's the 100 days essentially.

CHAIR CORRADINI: That's where Dick was asking the 30, the 50 and the 100 question.

MEMBER SKILLMAN: Let me say what I would like to say here. I understand the first one.

The reactor shuts down, stays shut down because you've got all the rods in. Sure.

The second case is the worst rod stuck out. You say if we catch that within the first 70 percent of the equilibrium fuel cycle, 24 months you're out about 15, 16, 17 months, your boron concentration's dropping 16 to 18 hundred.

And now you're down to about 500, 400 VBM.

MR. BOTHA: Um-hum.

MEMBER SKILLMAN: A number like that. The reason from 70 to 100 you're stuck is because you can't move enough water fast enough. Because you don't have a safety grade injection system.

MR. BOTHA: That's correct.

MEMBER SKILLMAN: Okay. Hold that

thought. And the third one, --

MR. BOTHA: I don't think --

MEMBER SKILLMAN: Yeah. It is.

(Off mic comment)

MEMBER SKILLMAN: No. It's not fast.

MR. BOTHA: Well, it's not --

MEMBER SKILLMAN: It's not.

MR. BOTHA: So you can add with CVCS. I mean, you can add boron. But that's non-safety.

MEMBER SKILLMAN: You can pray. You can pray you get it in there.

MR. BOTHA: Yeah. Sure. Sure.

MEMBER SKILLMAN: And the third one is fun because you're depending on boiling.

MR. BOTHA: Yes.

MEMBER SKILLMAN: You're depending on voiding. And so what adds to your favor is having an abundant amount of decay heat --

MR. BOTHA: Yes.

MEMBER SKILLMAN: In the degeneration rate.

MR. BOTHA: That's correct.

MEMBER SKILLMAN: But the same thing that you're counting on for boiling to be the very phenomenon that is injuring your fuel.

So it just seems to me that you've lined up some conditions here for your benefit that maybe treacherous for the safety of the core.

MR. BOTHA: Yeah, so we -- so as part of the safety analysis, we analyze each removal with boiling, with our ECCS system, with maximum decay heat.

So that's done as part of the safety analysis. So, this condition is with substantially less boiling.

But just if you look at the normal decay heat, so now you're talking about three megawatts and more, right? That you're removing heat with your ECCS system.

But boiling at those conditions are -- it's a very low power density that you're talking about in terms of the amount of boiling and heat you're removing.

And as Ben's going to cover later, your ECCS system is more then sufficient, more then capable to remove that heat. And doesn't present a challenge to your fuel because you -- at those conditions you're essentially at -- you're getting down to the 200 F or Fahrenheit.

So it's low temperatures. So the boiling you're talking about is not a lot of heat. It's not nearly enough to heat up your cladding.

So it's a very -- if you're talking about this condition, it's a very benign, safe condition.

MEMBER KIRCHNER: Derick, when this condition occurs, are you depressurized?

MR. BOTHA: In this specific condition, yes. So --

MEMBER KIRCHNER: So you have more boiling --

MR. BOTHA: That's right.

MEMBER KIRCHNER: At lower pressure.

MR. BOTHA: That's right.

CHAIR CORRADINI: But if I might just return, unless I misunderstood your white paper, the reason that you're not concerned is because you should be far away from CHF.

MR. BOTHA: That's correct.

CHAIR CORRADINI: So boiling is perfectly fine as long as I'm nowhere close to CHF.

MR. BOTHA: That's correct.

CHAIR SKILLMAN: Thank you for the perspective.

MEMBER MARCH-LEUBA: Let me give another perspective

MEMBER SKILLMAN: I'm done. Thank you Gary, thank you.

MEMBER MARCH-LEUBA: Also, I'm not an expert on NuScale, I haven't reviewed it yet. So, bear with me.

But there is a large fraction of the breaking domain in time of NuScale where nothing happens.

MEMBER SKILLMAN: Um-hum.

MEMBER MARCH-LEUBA: This is no fraction where we may -- something may or may not happen. Right?

And there's a critical power which now you call it 100 kilowatts, call it 50, call it 200.

MEMBER SKILLMAN: Um-hum.

MEMBER MARCH-LEUBA: But if you are above it, you will get an insufficient boil to keep the reactor subcritical.

And typically achieve that with decay heat.

MEMBER SKILLMAN: Um-hum.

MEMBER MARCH-LEUBA: So, and if you are below that power, and below the power, you can have the critic up higher.

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: You don't produce sufficient boils to main it subcritical. So the maximum power that you can achieve before the criticality, --

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: Is less then normal decay heat.

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: Is that correct?

MR. BOTHA: That's -- substantially it's saying it is.

MEMBER MARCH-LEUBA: So the worst thing that could happen if you go critical is you stay at early decay heat is still continuing to decay.

MR. BOTHA: That's right. That's correct.

MR. SCHULTZ: Derick, the discussion here focuses on the best estimate as you've indicated to an extent.

MR. BOTHA: Yes.

MR. SCHULTZ: And you not the equilibrium fuel cycle condition.

MR. BOTHA: Yes.

MR. SCHULTZ: Are there other fuel cycles that maybe anticipated that would be worse?

MR. BOTHA: We don't expect so, because -- and Allyson, you can add if I stray here.

But if you look at other fuel cycles, you'll control that worse. We're expecting it will

essentially be about the same.

We don't expect that a significant departure from our control efforts that we have.

MR. SCHULTZ: So before one gets to an equilibrium cycle, those cycles should be not much different in terms of this --

MR. BOTHA: That's right.

MR. SCHULTZ: Issue and condition.

MR. BOTHA: They typically start with high boron and dilute the boron as you go through this.

MR. SCHULTZ: Sure. Thank you.

MR. BOTHA: So, next slide. Thank you. So, we looked at these conditions and then we used PRA to conservatively try and estimate what the probability of such an occurrence would be.

So, and the number that we calculated is that it would be less then 10E to the minus 6 per reactor module year. And the number is a contribution of really three factors.

The first one is a probably of a stuck control rod. So we just said any rod, not the worse one. Just the probability of any rod would be stuck.

We also looked at the probability that your CVCS would fail on demand. So if you would prepare it to function it wouldn't be available.

And then the last probable -- the last contribution would be the probability that you were in this condition where you were operating through a normal fuel cycle, shut down for a long time, and restarted at the latter part of your fuel cycle. And then ended up in this condition.

And again, that's a conservative estimate.

MEMBER MARCH-LEUBA: What is your loss of offsite power and battery power built into this?

MR. BOTHA: It takes that into account. But I have --

MEMBER MARCH LEUBA: You don't take credit for that quality? Or do you?

MR. BOTHA: No, so this is -- with PRA we look at the probability of losing power. But that's a -- you can use your onsite power systems even if you lose offsite power as well.

Which seems to --

MEMBER MARCH-LEUBA: All right. But that's where I was going. If you do take credit for the batteries, the batteries have no safety rate.

MR. BOTHA: That's true, correct. But the battery -- we can't use the batteries to charge with CDCS.

So the batteries --

MEMBER MARCH-LEUBA: But they cannot be used to test CDCS?

MR. BOTHA: That's right.

CHAIR CORRADINI: Can or cannot?

MR. BOTHA: Cannot. Cannot.

MEMBER STETKAR: Let me just make a comment. Without having seen one iota of your PRA models, data, or assumptions, these numbers are meaningless to us.

That is simply a statement that I wanted to put on the record. It's my own personal opinion. They are meaningless without the committed background.

MR. BOTHA: Yes. So, you would --

MEMBER STETKAR: So you could put any numbers up there. Until we have an opportunity to actually review the PRA, look at the completeness of the scenarios, look at the frequencies of the scenarios, including external events like seismic events. Including internal fires. Including internal flooding and anything else you can think of, these numbers are meaningless.

MR. BOTHA: Sure. So I understand your --

MEMBER STETKAR: So, probabilistic assertions at this stage in the game, in my mind, don't

carry much weight. Because -- at least with me, because I've not had the opportunity to look at any justification for any of those numbers.

MR. BOTHA: Sure.

MEMBER STETKAR: Any of the three numbers that you cite on this slide.

MR. BOTHA: And while you wait for an opportunity to look at the numbers, some additional information I can give you is the first number there, the stacked rod probability is based on industry data.

So, our control rods are similar to the existing control rods in industry. And then the second number in there --

MEMBER STETKAR: I'm familiar with that data. And it's very sparse. And there's very large uncertainty in those estimates.

Go on.

MR. BOTHA: Sure. Thank you for the comment. So --

MEMBER BROWN: Probably being the one with the least knowledge of all this, I'm an electrical guy. So, in your white paper you make the statement -- I'm trying to connect -- you're telling me why things won't happen.

But yet in your white paper you state that

under normal and accident conditions with a postulated limiting stuck rod and conservative assumptions of low level return to power is predicted during long term response.

And that, I haven't heard anything that you've -- that lays out how does that occur when we talk about long term response.

Does that mean -- I just can't connect the dots --

MR. BOTHA: Sure.

MEMBER BROWN: Based on the earlier discussion. And it was right on the first page of your white paper.

MR. BOTHA: White paper. I understand.

MEMBER BROWN: So, to me that doesn't sound consistent with what you've been going through this stork dance for the last half an hour.

MR. BOTHA: Sure. And the purpose of the stork dance, if you may, --

MEMBER BROWN: I wasn't trying to be pejorative. It's just --

MR. BOTHA: I understand.

MEMBER BROWN: It's just the back and forth is what I meant.

MR. BOTHA: Yeah. So that's a good point

that we're going to be transitioning and having a little bit of what you mentioned.

But the purpose of that was really to give you a sense of what we realistically expect to occur. And I'm going to be handing it over to Ben.

But just to give you a short answer there, is the purpose of the Chapter 15 analysis that gets mentioned in the white paper, is going the opposite way.

It's not looking at what's realistically going to happen. It's looking at well, if I take these considered assumptions, I can now demonstrate to you that this is not going to endanger the fuel.

And then you end up, if you're going to take those considered assumptions, you end up with an event that looks very different then that. But that's because of the conservative assumptions.

So, I'll take this opportunity to transition to Ben Bristol.

MEMBER KIRCHNER: Well, one --

MEMBER BROWN: Let me -- can I finish?

MEMBER KIRCHNER: Go ahead.

MEMBER BROWN: I'm sorry. I didn't mean it that way.

I guess I was under an understanding that

we typically, and my colleagues can correct me if I'm wrong, but we typically license stuff under a set of conservative accidents.

MR. BOTHA: You're correct.

MEMBER BROWN: And you're effectively arguing that we don't have to meet those in order to say we're okay. That's what the purpose of the exemption is.

That's what -- that's what I -- that's the way I read what you said just now.

MR. BOTHA: So, I would -- I think the exemption request and the reason we're asking for that is I would decouple that from the safety analysis, which Ben will very briefly address.

He's for the most part going to talk about some of the inherent characteristics of our design. And I -- so that's not necessarily the same question.

I think the question of the exemption is, do you meet the requirements? And if you don't, you need to go through an exemption process to demonstrate that it's acceptable.

But the question of the safety analysis, which is in the application, so that analysis is presented as part of our Chapter 15, is to answer the question, well will I challenge the fuel with

conservative assumptions.

So, those I think are two separate questions.

MEMBER BROWN: Okay. One more to go. Maybe you're going to address this later, but --

MR. BOTHA: Sure.

MEMBER BROWN: If a response came back and said no, we don't accept the exemption. And we don't agree that you can allow -- you'd have to comply -- not comply.

You have to do what other plants have done.

MR. BOTHA: Sure.

MEMBER BROWN: How would that -- is that -- are you all going to talk about what -- how that impacts your plant design?

MR. BOTHA: So we --

MEMBER BROWN: What do we get in other words if -- there ought to be a reason for why you're doing that to some degree.

MR. BOTHA: That's correct. So we are going to -- after Ben's slides, I'm going to get back to some of the design considerations.

And I'll touch there on the reasons we purposely did not look at alternatives. So these things you could do in the design and the specific

reasons we opted not to do them.

But, I think I'll, if it's okay with you, wait until we're through.

MEMBER BROWN: I'm through. I just wanted to make sure it was going to be talked about.

MR. BOTHA: Sure.

MEMBER BROWN: Okay. Thank you.

MEMBER BLEY: And before we go ahead, there's a couple of things I want to toss on their table. I'm not expecting you to respond to these.

My colleague Mr. Stetkar, said we haven't seen where these numbers come from. And that's true.

On the other hand, we haven't seen all of the details of the thermal hydraulics numbers or the neutronics that back up the rest of this. We have to see all of that eventually.

MR. BOTHA: Sure.

MEMBER BLEY: So, at this point in time, there's no way we say everything's good. But, I think what we're being asked to say is, if the analysis support the things we've heard, is this a reasonable approach?

CHAIR CORRADINI: Can I just interject with that?

MEMBER BLEY: Okay. But I want to finish these before --

CHAIR CORRADINI: All we're going to be asked to talk about -- all were being asked to talk about today is do we agree with the suggested criteria by the staff.

MEMBER BLEY: Very good. The DDC itself, and all of us know this, says what they need to do is maintain the capability to cool the core.

It doesn't say anything about all these other things. We've added the other things along the way, often because they're simple substitutes for what we're really trying to do.

From my point of view, it's always fair to go back and say, should we do that? Or should we do more precise and more accurate in how we deal with these things?

And the last thing is our deterministic and conservative analysis that are done, the stand ins for kind of the right thing, because it's easier. And it's always fair to look beyond that.

When we apply those and start applying them to areas that are extremely unlikely, the real place we ought to be -- the way we ought to be thinking about that to me, is in a probabilistic point of view.

And they're bringing some of that in. And eventually we have to deal with that.

But, I just wanted to get those thoughts on the record for our deliberations later. Go ahead.

MR. BOTHA: Thank you. So I'll take this moment -- sorry.

MEMBER KIRCHNER: I just wanted to ask -- I've got a question and a clarification. You said that the CVCS function -- and there was a dialog between you and the Chairman on this CVCS.

And this is not powered by the battery system?

MR. BOTHA: that's correct.

MEMBER KIRCHNER: So what is it powered by?

MR. BOTHA: AC power. And you can power it with your onsite AC sources.

MEMBER KIRCHNER: Okay.

MEMBER BLEY: We're going to be looking at the AC power system for this plant later. We looked at --

MEMBER KIRCHNER: Yeah.

MEMBER BLEY: The generic thing a while back. Where they proposed a highly reliable instead of safety grade, and wrote a letter on that.

And this is the highly reliable system. They're not using it here.

MEMBER STETKAR: That was DC. Highly reliable DC.

MEMBER BLEY: Yeah. But we argued it was both at the time.

MEMBER STETKAR: Yeah.

MEMBER BLEY: Because they were coupled together.

MEMBER STETKAR: We did.

CHAIR CORRADINI: Keep on going. You're going great.

MR. BOTHA: Thank you. So I'll use this opportunity to give Ben Bristol a chance to discuss the consequences of a return to power and some of the inherent features of our reactor control.

MR. BRISTOL: My name is Ben Bristol. I have a Bachelors and a Masters Degree in Nuclear Engineering from OSU. I've been with NuScale for five years working in the safety analysis and safety engineering organizations.

As Derick mentioned, we're going to get into a little bit of what this event could look like. How the event progresses. And what the consequences are.

So, to jump off the cooling the core concept, one of the primary things we're focused on

is, would this event challenge the systems that we passively designed, Derick described them a little bit earlier that are set out for core cooling and these longer term passive functions when we don't have AC power.

What we see is that whether the event be a single rod stuck out, return to power event, or even an event where all of the rods are out, both of those systems are designed such that they scale and can remove that heat.

And that's due to some of the self-limiting characteristics of those systems that I'll describe next.

So, if we were looking at an event that progresses to our decay heat removal system actuating, and that's the secondary loop, passive system, those are events that don't involve breaks inside containment.

If we have a loss of feed water for instance, we would get a reactor trip on high temperature or high pressure. That comes with the DHR actuation.

As Derick mentioned earlier, the immediate analysis of the event shows that the shutdown capability of the rods with one stuck out is more then sufficient

to take the core subcritical for an extended period of time.

Eventually DHR will continue to cool the RCS down to temperatures where this event could be postulated. And what we see there is a moderator temperature driven event, a little bit like a steam line break.

These time scales are fairly different. We have a power response. Ultimately the power causes an increase in RCS temperature. And that turns the power back around.

And we would reach an equilibrium condition where the power is matched by the particular ability of the DHR to remove the heat.

MEMBER KIRCHNER: What power level is that that you estimate?

MR. BRISTOL: So the equilibrium power level in our conservative analysis is about three megawatts.

MEMBER KIRCHNER: So, perhaps another way to say it, and this is pejorative, you end up in a situation where you have the criticality, and you're not really controlling it.

You're hands off and you're depending upon a natural phenomenon, whether it's boiling, water

temperature coefficient, whatever the coefficients are, to limit that power level from going any further, from increasing from that three megawatts.

So there it sits from now until whenever. Isn't that the situation that you're pointing to?

MR. BRISTOL: That's correct.

MEMBER SKILLMAN: Okay. So it sits there for six or eight months. Why is that okay?

MR. BRISTOL: That's incorrect.

MEMBER SKILLMAN: Thank you. Correct me -- I'm not going to be corrected. You know, I watch -- please proceed.

MR. BRISTOL: So, the event progression that we'll get into, as Derick mentioned a little bit earlier, is if we're in a situation where we have AC power available, operators have the ability to add boron, and we would mitigate the event that way.

If we have an extended loss of AC power, what eventually happens is -- will result in the load shedding that Derick described, where we actuate ECCS.

And then we go to the other mode where we have the ECCS driven event. Which I'll get into in the next slide.

MEMBER SKILLMAN: Will you give a time scale for what the operator actions will result in?

Will you have a time line that if you are in the situation, approximately how long that will take to bring the core to a subcritical --

MR. BOTHA: So I think what he just described is if you go through the normal sequence of -- thank you. What he just described is, if you go through the normal sequence of events, you wouldn't see this return to power on DHRS.

You would transition, so for normal sequence events, you would transition to your ECCS system automatically. So there's no operator action required, because the system sheds the load on the ECCS valves.

But that's what -- what actually would happen.

CHAIR CORRADINI: I'm going to interject that I don't think you're answering Dick's question.

MR. BOTHA: Sure.

CHAIR CORRADINI: But I'm not sure that you guys are on the same wave length. The way if you read the words, is you don't get a return to power.

MR. BOTHA: Under normal conditions --

CHAIR CORRADINI: Unless you have a set of conservative assumptions under Chapter 15. And I'm not sure that we're clear yet as to what those

conservative assumptions are.

That's -- and I think Dick's asking is with those assumptions, --

MR. BOTHA: Sure.

CHAIR CORRADINI: How long do you remain critical?

MEMBER SKILLMAN: That's my question. And what actions are you taking? And how long does it take those actions to stop that criticality?

MR. BRISTOL: So what we demonstrate in the analysis is that we'll reach an equilibrium condition and stay there. That condition doesn't challenge the ability of ultimately the pool to keep removing the heat.

And so therefore if we were to stay in that condition out to 24 hours when we have this automatic actuation of ECCS that still doesn't provide any additional challenge to our heat removal capabilities.

CHAIR CORRADINI: So it -- so at the minimum it stays critical for 24 hours. At low power.

MEMBER BROWN: At three and a half -- roughly three or three and a half percent power -- megawatts, excuse me.

MR. BRISTOL: Yeah. You could postulate that if we're considering Chapter 15.

CHAIR CORRADINI: Right. Well, that's where I think he's going. Let me push the point.

So tell me what happens at 24 hours by natural logic of the design.

MR. BRISTOL: So, the last bullet describes condition again, this nominal versus conservative. Our nominal condition in these operating modes, there's sufficient zenon in the system to provide the negative reactivity necessary to overcome the conservatism of the stuck rod.

MEMBER SKILLMAN: That's gone after about eight to 12 hours.

MR. BRISTOL: So again, out to 24 hours they're sufficient under the equilibrium conditions in combination with the cooling curves, such that the event doesn't occur.

MEMBER BROWN: And what about the Chapter 15 conditions though?

MR. BRISTOL: In those conditions we predict just based on conservative assumption of decay heat that we see the event within about two hours.

MEMBER BROWN: And how long -- I mean, that's when you get to three or three and a half megawatts?

MR. BRISTOL: That's correct, yes.

MEMBER BROWN: And how long does it last then? Is that a day or --

MR. BRISTOL: So we haven't established --

MEMBER BROWN: Two days, or three days, or four days? Or a week?

MR. BRISTOL: That would -- it would be up to 24 hours when we transition to ECCS mode.

MEMBER KIRCHNER: And what happens then?

MEMBER BROWN: Yeah, what happens at 24 hours that you transition? Under the conservative Chapter 15 conditions.

MEMBER STETKAR: Just don't -- with no boron addition. Just say with no boron addition. What happens then?

MEMBER KIRCHNER: Yeah.

MR. BRISTOL: That's implied in all of this conversation.

MEMBER STETKAR: Not conservative, not 24 hours, not Chapter -- with no boron addition, what occurs?

MR. BRISTOL: There's no boron addition. You can go to the next slide. So, in ECCS mode what we have is --

MR. BERGMAN: Ben, I -- Tom Bergman. I

think the question is, what causes us to go to ECCS at 24 hours?

There's a -- the batteries have a timer that actuates ECCS after 24 hours by take -- that's what he meant by shed the load.

The batteries shed the load at ECCS after 24 hours.

MR. BRISTOL: So, but you've got that --

MEMBER KIRCHNER: So you're at power, you're at 24 hours, and then your battery timer or something sheds the load and --

MR. BERGMAN: ECCS actuates.

MEMBER STETKAR: You transfer the flow path.

MEMBER KIRCHNER: Yeah, to ECCS.

MEMBER STETKAR: Is what they do.

MEMBER KIRCHNER: So that depressurizes the system at that point, right?

MR. BRISTOL: That's correct.

MEMBER KIRCHNER: Yes, at 24 hours. If that happens then you'll depressurize.

MR. BRISTOL: Yes.

MEMBER KIRCHNER: And you're still at three megawatts?

MR. BRISTOL: At that time we would be,

yes.

MEMBER KIRCHNER: And so for now -- to what pressure roughly does the system depressurize?

MR. BRISTOL: It will ultimately depressurize down to sub-atmospheric conditions.

MEMBER KIRCHNER: Okay. So at three megawatt power level in the core, you could create substantial void, which is negative feedback.

MR. BRISTOL: That's right.

MEMBER KIRCHNER: Would you then invite the possibility of oscillations like in BWR?

MR. BRISTOL: So --

MEMBER KIRCHNER: Do you see what I'm saying? If your void production is substantial, you could create density waves of some kind at the core.

MR. BRISTOL: And that's why our analysis of --

MEMBER KIRCHNER: Collapses and goes to a higher power.

MR. BRISTOL: Sure.

MEMBER STETKAR: We got an answer. Well, I want to get past the minutia of what's happening in seconds and minutes, and figure out what's happening out oh, like 67 hours after the initiating event occurred. With no boron addition.

Where are you at 67 hours? And that's an arbitrary time. Because I don't want to get tied up with 24 or 48 or 72, or words like conservative or anything.

So, at 67 hours, where does the core sit? What is your power level in the core?

MEMBER MARCH-LEUBA: Can I help you guys? They will have sufficient negative reactivity. From the boron and the control loss to keep the reactor so cooled.

Unless particularly for a critical void fracture in the core. Let's call it 10 percent. If you look at 10 percent voids in the core, you're super heat.

You must generate enough power to use 10 percent void in the core. And you have to remain at 10 percent in the core either with decay heat --

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: Will regardless of how first coming down from fission product or from neutrons. But you will produce a critical void that you need.

And that's the real condition. So, at core pressure, that's three megawatts. When you go to a lower pressure, to 15 percent power, you only need 50

kilowatts.

But you will never get any more then 10 percent voids because this will be critical. You cannot go above 10 percent voids.

The reactivity balance in the core does to allow it. That's all their problems. But, I mean, I will go from that point, it's you have critical void fraction that will keep you safe.

And the core is going to maintain it one way or the other.

MR. BOTHA: Sure.

MEMBER KIRCHNER: If you go subcritical, then what happens?

MEMBER MARCH-LEUBA: If the decay heat is sufficient to generate more then the loss, 10 percent voids, you don't have neutrons. You only have gamma sent out.

And once decay heat starts going down and you have 10 percent voids, then --

MEMBER STETKAR: That's right. Then the neutrons are going to make up for the difference.

MEMBER MARCH-LEUBA: Yes. There will be some constants where there's a long time for this thing, the transition is less then an hour.

And because, I mean, it can last -- so your

time is a thousand seconds, two thousand seconds, we're going through the loop.

So, there will be some solutions.

CHAIR CORRADINI: So, have we interpreted your behavior correctly? Since the members over here collectively told you how it would behave.

(Laughter)

MR. BRISTOL: Yes. That's consistent with my points on this next slide.

We have a depressurization event in which case the conditions are much different then when we're in single phase conditions during DHR cooling.

And the analysis we have shows it takes very little power to suppress the critical condition such that it's well bounded by our analysis of the normal decay heat conditions that we apply in our accident analysis.

So the next slide --

CHAIR CORRADINI: But to get to -- I'm going to not let Stetkar off the hook. He asked a question, he kind of deserves an answer.

What I'm hearing is that, and I think Jose said it best, is that either a combination of decay heat or a little bit of fission power is going to keep it at some void fraction that without anybody touching

it is just going to sit there and cook along.

MR. BRISTOL: That's right. And that's similar to our other mode in DHR where ultimately we reach a power level that's equal to the DHR heat removal capabilities.

And this would be the same case.

MEMBER STETKAR: That's what I was hoping you would show. (Off mic comments) The power plus the -- sorry.

The power plus the decay heat is enough to give you sufficient void fraction to establish an equilibrium condition.

When do those analysis, same question I asked about heat removal efficiency. Your best estimate analysis for DHRS. Do you have two loops or one loop operating?

What assumptions do you make about heat transfer from the core all the way out into the pool? Because that's going to determine that core power level.

MEMBER MARCH-LEUBA: Yeah, that three megawatts, maybe when you sharpen the pencil we'll know exactly how everything works. Maybe then.

MEMBER STETKAR: Yeah. And have you looked at long term core decay heat removal? Not

Chapter 15 analysis. Not 24 hours.

But how long can you sit there before you have to put water in the pool? In the reactor pool, the swimming pool? With 12 problems.

MR. BOTHA: I think that's a good overall question in terms of a NuScale safety of the plant. But just keep in mind that you only get into this long term condition when you're at very low heat values.

So less then decay heat. So, for you to --

MEMBER STETKAR: No, wait. Maybe I'm not understanding what I just thought I walked you into.

MR. BOTHA: Sure.

MEMBER STETKAR: If you have low decay heat, the reactor power is going to make up for the difference.

MR. BOTHA: That's right.

MEMBER STETKAR: If you have hot decay heat the reactor power is --

MEMBER MARCH-LEUBA: Maybe higher.

MEMBER STETKAR: Is -- might be a little bit higher. But --

MEMBER MARCH-LEUBA: The thermal power would be higher, because it's higher then the critical.

MEMBER STETKAR: Yes.

MR. BOTHA: Sure. But after 24 hours though, you're on ECCA. So, the amount of power you're talking about when you have a return to power is in order of 100 kilowatts.

So, if you talk about how much water I need to remove heat, then the conservative case is not this case. The conservative cases are one where decay heat curve where you're not subcritical.

Because then you're putting more water into your pool. If I've got decay heat, then I'm talking about two orders of magnitude more.

Or so I have an order of magnitude more heat then I have to produce. Or that will be producing from decay heat.

Which will keep me subcritical. But that will add more heat to my pool then in the 100 kilowatt case.

CHAIR CORRADINI: I think where Member Stetkar is going is do you have enough inventory to stand back and watch 12 of these things boil away? That's what I think --

MEMBER STETKAR: For some nominal period of time?

MR. BOTHA: Yes, so --

MEMBER STETKAR: And I don't know what the nominal period of time is.

MR. BOTHA: So the answer is we have got enough water for more than a month, and it's substantially more than a month --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: Let me make sure I understand what was said before.

MR. BOTHA: Yes?

MEMBER MARCH-LEUBA: The transfer to ECCS those valves are kept closed by the batteries?

MR. BOTHA: Yes.

MEMBER MARCH-LEUBA: And whether somebody opens them up or you lose power after 24 hours they will open in 24 hours, right?

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: So, for instance --

(Simultaneous speaking)

MEMBER BLEY: If the circuitry works, yes.

MEMBER MARCH-LEUBA: For a substantial amount of time you are talking the depressurized power, which is 100 kilowatts not still megawatts right?

MR. BOTHA: That's right.

MEMBER MARCH-LEUBA: Times 12 is a still 1.2 megawatts. It will require calculation, but it's not --

MR. BOTHA: Yes. So the short answer is

it's not a safety concern.

MEMBER MARCH-LEUBA: But with that said I think that Dennis is right, what we're just talking about today is not the details of those numbers.

MR. BOTHA: Sure.

MEMBER MARCH-LEUBA: It's whether GDC 27 applies or not and that's where we should be focusing and then you come back here and convince us.

(Laughter)

CHAIR CORRADINI: I am going to take the charge. I am glad you said that because I want them to continue because we have strayed a bit off track and as engineers we love the design, but can you proceed on because I want to get to the Staff's presentation and their criteria and if they think it's an appropriate criteria.

MR. BRISTOL: Okay. So this is a little bit of a summary slide that is just meant to explain the scalability nature of both our ECCS and our DHR heat removal capabilities.

As RCS temperature increases both those systems will remove more heat, and then the triangle and the asterisk there are the equilibrium conditions that we expect in DHR mode and in ECCS mode.

MEMBER SKILLMAN: Mr. Chairman, I'd like

to back up. I understand your desire to drive on, but let me just ask you to go back one slide.

Either Derick or Ben, your comment, almost closing comment on the previous slide was yes this criticality will continue but it's not a safety problem.

If you look -- If you check the transcript I think you're going to find those are the words that you used.

MR. BRISTOL: That's correct.

MEMBER SKILLMAN: To me that is the challenge in this meeting. What you have described as not a safety problem I see is a major safety problem. You have said it can be handled.

MR. BRISTOL: Yes.

MEMBER SKILLMAN: You have said the natural phenomenon will take care of it. I would say that is dandy, but that doesn't make it not a safety problem, that makes it managed, but from my perspective it's still a safety problem because you've got a criticality that you are not in charge of.

MR. BRISTOL: Yes.

MEMBER SKILLMAN: It is a criticality that you are depending on natural phenomenon that you think take care of it, and you are probably accurate. I don't challenge your capability to think it through from a

physics and a neutronics perspective, and a thermal hydraulic perspective.

But I think just the notion that we are saying, yes, we can handle a meandering criticality because in the course of time we know it's going to be controlled, I am not sure that that's where we ought to be as an industry and as a vendor.

And most of all, as we look at general design criteria, at least those of us who were around them in the early days, 26 and 27, it's almost unthinkable, speaking for myself.

MR. BRISTOL: Yes.

MEMBER SKILLMAN: So I am stuck on this idea that it's not really a safety problem. I believe it is an operating challenge that remains a safety problem.

MR. BOTHA: So I think I can respond to that when we continue to the next slide.

MEMBER SUNSERI: Could I just maybe provide a different view?

MR. BOTHA: Sure, go ahead.

MEMBER SUNSERI: I think it's the nature of these new passive designs that design becomes a controlling parameter and you are controlling the design and you are saying the parameters with the design

to control this criticality under these circumstances.

So it's not like it's some willy-nilly reactor where the rain is making the thing critical --

MR. BOTHA: Yes, that's correct.

MEMBER SUNSERI: -- it's a very controlled design specific, that type of controlling criticality is through the design.

MR. BOTHA: That's correct.

MEMBER SUNSERI: So that's my fundamental issue with the NRC's position that says it's not reliably controlled. It is reliably controlled, it's not just reliably controlled through an active system, it's reliably controlled through a well-thought-out design.

MR. BOTHA: Yes. Thank you, I appreciate that comment. I think that fits in well with the next slide. Thank you, Allyson. So we are going to address the design considerations so I think that's an appropriate comment.

And with respect to the design considerations I think the inherent safety, as you pointed out to the design, is pretty fundamental for us in terms of our overall design principles and as Ben pointed out if you look at the reactivity control, inherent capabilities of this design, it's not just

about a single rod but also there is a capability because of those inherent bits of feedback mechanisms that you can tolerate additional failures of multiple rods which traditionally may not have been the case with earlier designs.

So I would argue relying on those bits of inherent features gives you the means to provide additional safety and additional reliability, but back to the presentation.

So we purposely elected to use standard magnetic, or mag jack control rods. Firstly, because there is a lot of experience with that in the industry, it's well understood, and also it is well suited to our design.

We have also looked at well is it sensible to add additional reactivity control systems in terms of safety-related control systems and we found that that does not provide you additional safety if you add these additional systems.

So we felt that the systems we have is sufficient given that the inherent capability of the design and also if you take into consideration that the probability for a stack rod is extremely low.

That is not an apples to apples comparison, but if you compare 2E to the minus 4 to a typical EECS

system of liability that's very favorable.

And then after successful control rod insertion you don't have to do additional things to protect your core because it is protected.

And then if you look at relying on this passive means for insertion, if you add additional systems, so we looked at those, that does not necessarily make the plant more safe in terms of reducing your core damage frequency, but what it does do is introduce additional failure mechanisms.

So by adding other systems you are increasing the complexity of the design and introducing additional things that can fail. So if you add a boil injection system, for example, the practical way to do that is to put it outside of containment and now you have an additional penetration that is coming in through your containment and reactor pressure vessel that can fail and lead to containment bypass.

And if you look at the overall systems in terms of their safety containment bypass is one of the vulnerabilities for the exiting feat and something that we don't want within our design. Next slide.

MEMBER STETKAR: Doesn't your CVCS already have one of those penetrations?

MR. BOTHA: That is correct --

MEMBER STETKAR: Okay.

MR. BOTHA: -- but you would add additional ones, yes.

MEMBER STETKAR: No, no, if you made your CVCS safety-related you wouldn't need an additional penetration, so I am not persuaded by that argument.

MR. BOTHA: Yes.

MEMBER POWERS: And it wouldn't be a passive design.

MR. BOTHA: It wouldn't be a passive design.

MEMBER STETKAR: That's correct, it wouldn't, by chance.

MEMBER POWERS: But it would be a safe one, huh?

MEMBER STETKAR: It would be a different design.

MEMBER SKILLMAN: Before you go on, has the NuScale team ever considered what the operator's environment would be if this event occurred in one of the modules?

MR. BOTHA: So if you look at what we expect to normally occur they wouldn't have to do anything for a very long time and if they have AC power systems available they will go through their normal shutdown

sequence, so this wouldn't change how they operate the plant.

As part of the -- As soon as you get systems back online, to go to your normal refueling system you have to add water, you can do that with your CVCS, we also have a flood and drain system that we use as part of our shutdown sequence.

So all of those systems are there and to go to refueling you have to go and use those systems.

MEMBER BLEY: I'll chime in something here quick, when we had our trip out to the site several years ago we got to watch a series of drill exercises in the control room ending with a cascading of many problems.

My impression was I saw a lot more effort to involve the operators in designing the displays and the ability to deal with those displays than I have ever seen elsewhere.

I don't know what's happened since that time, and I hope before we finish this process we get to see something here that shows us where that practice has evolved and how the evolution of the control room indication alarm and control systems have, what state they have reached by now and the extent of operations involvement in them, because I think that is going to

be crucial to the ability to decide whether, at least for us to decide whether we think this is going to be an operable design, so I look forward to seeing more of that later.

MEMBER SKILLMAN: Yes. My purpose is not to be a cynic and it's also not to be negative here, it's to be a challenger.

I just remember in an incident of one weeks and weeks and weeks of good people like us looking at instrumentation saying is it critical or isn't it and if it is what more can we do.

And that didn't, that sense of trepidation did not pass quickly, it went on for months, and so I can imagine men and women in the control room saying we think we are okay on Module 4 but after we've had the worst event occur.

We think it shut down but we're not sure, we think it's going to be okay because it's going to take care of itself, but we don't know quite when. The end will come.

And I would just suggest that brings into this design a peculiarity that we can see coming even now, because there isn't the certainty that you can bring this core to a complete subcritical situation under these circumstances.

And it seems to me that that is a question that deserves a compelling and strong answer. We know we can shut that thing down, and that's why I am picking on you.

MR. BOTHA: Yes. I appreciate --

MEMBER SKILLMAN: I am affected by previous experience where a number of men and women were involved in this and it just didn't go away easily. It was really a nightmare.

MR. BOTHA: So I think in that particular plant, in that plant to get to cold conditions you had to insert rods, although you could account for a stacked one, but then you also had to inject boron to get to subcritical conditions to ensure you were safe.

MEMBER SKILLMAN: Six thousand PPM?

MR. BOTHA: That's right.

MEMBER SKILLMAN: That's correct.

MR. BOTHA: So you need to do both those things. With this plant you can get there with rods only. So you can get to a condition where you can ensure safety without the need for additional boron.

You have that capability and you will use it, but you don't need it to ensure safety. So that provides additional protection then having to require rods and injection.

So I think if that's -- If you stand back and look at the design holistically, which we did, and we also looked at it within the context of the advanced reactor policy statement, which was intended for the NRC to bring about advanced reactors that are both safer and easier to license.

So some of the goals that they put in there had those two objectives in mind. And so if you look at our design and the choices we made, the first one is by relying on rods you have a system that is highly reliable and less complex, and then further, as we discussed, the reactor provides inherent protection even if you were to see failures within that control rods, new control rod system.

And I've got some quotes here, and I'm not going to read the quotes, I am simply going to state, so that would be the first quote. For the second quote, so consistent with that quote, we provide a simple shutdown system, control rods that passively insert into the core and doesn't require operator action, so you don't require operator action to get into that safe state and it facilitates operator comprehension and provides for reliable system functions.

And then, lastly, the control room system design that we elected builds on extensive operating

experience with the existing PWR.

MEMBER BLEY: Derick, you kind of, at least for me you missed Dick's point a little bit.

MR. BOTHA: Sure.

MEMBER BLEY: It's one thing to say you were retaining capability to go with the core, which is what the GDC asked us to do. It's another, for an operator in the plant, not an engineer having done a calculation looking at it comfortably in the office, but sitting in the plant with a plant that is cooking away, it's low.

(Simultaneous speaking)

MEMBER BLEY: When we look at how the operators are going to be trained and how they are going to use this facility we're going to be interested in how they know that this situation where they are not completely shutdown, and they're pretty sure they are not completely shutdown, how they understand that and how they deal with it and how they continue and have comfort, which is a different thing than the engineer saying, yes, I'm sure it's okay, ahead of time.

MR. BOTHA: Yes.

MEMBER STETKAR: They are sure by the way they are not shutdown because the instrumentation is safety-related, so they are going to know they are not

shutdown.

That is one of the things that they retained being safety-related, so that has to be available. They don't know they're not shutdown if they're not shutdown.

(Simultaneous speaking)

MEMBER BLEY: -- level of discomfort.

(Simultaneous speaking)

MEMBER STETKAR: And most operators traditionally have been trained to do something about that.

MR. BOTHA: Sure. And --

MEMBER STETKAR: And unless you untrain them or train them under the particular conditions that they need to keep their hands off they're going to want to do something.

MEMBER BROWN: Well and they are going to want to inject the boron, which unless the power isn't really isn't there they're going to do, so --

MR. BOTHA: That's right..

MEMBER STETKAR: There is another issue with perception I think but if you look at the state of trying to get plants built, designed and built and operated today that now we are going to advertise there's a plant sitting out there with just, you can't

shut it down unless if you are under these more adverse circumstances.

So Dick's point is valid. Matt's comments were valid also relative to the design of the plant, if I do understand the points.

MR. BOTHA: Yes.

MEMBER STETKAR: But perception can kill you in these types of circumstances in terms of a bigger picture.

I don't think we should totally ignore that factor that, gee, we're going to sit there for some long period of time and it's going to be critical, then over-producing neutrons, and they're going to be reading it on instruments and somebody can step back and say, my God, we've got plants that we can't shut down.

MR. BOTHA: Sure.

MEMBER STETKAR: And I just think perception can drive everything we do, which we have noticed over the last 35 years.

MR. BOTHA: Yes. So we went through those same deliberations in coming up with the design as we have it today. So we looked at the perception aspects and the operational aspects as well, and I think I have covered some of those points, so I understand your

points and the implications.

So with regards to precedent, we've briefly touched on the main steam line break and the return to power which you would see in Chapter 15. The precedent I am going to cover is more in, either in the PRA sphere of precedent that the Agency has looked at, as well as some of the GSIs.

So I am going to briefly go through this. The first one is GSI-22 where the Agency looked at inadvertent boron dilution. So this is when you are going into refueling, the head is off, and somebody adds deborated water to the system.

And there is a couple near misses in the industry with regards to this and this is the frequency based on those near misses that the predicted for inadvertent return to power.

And that wouldn't necessarily challenge core -- The part resolution is they said, well, you'll get some voiding, that will limit the power you produce, and, therefore, the consequences would be limited and, therefore, they didn't take any action on this GSI.

The next one is NUREG-1449 and that NUREG looks at, and for advanced ones has to look at the shutdown or low-power PRA so that you just don't look at your full-power cases but you look at what else could

go wrong during conditions we are at low power or shutdown and for the existing fleet they predicted a core damage frequency for a rapid boron dilution in the order of 1E to the minus 5 and that led to, that was for core damage, that wasn't just simply a return to power.

The next one is a lower probability. This had to do with small-break LOCAs and the potential for deborated water to collect in a certain part of your system.

You then turn on a reactor coolant pump and you push this deborated water into your core, that results in a rapid reactivity insertion, and core damage they predicted that to be 10 to the minus 9, or three times 10 to the minus 3, it was a very low probability event, and they advised to take that into consideration for the operators to recommend to them don't turn on the reactor coolant pumps.

The last one I think is relevant is ATWS. So when the Agency looked at ATWS and looked at the design considerations to address ATWS the goal, the safety goal that they established for addressing ATWS was 10 to the minus 5 per reactor year, so that was the goal of limiting core damage, your core damage contribution from ATWS.

So the actions that came out of that evaluation for BWRs and PWRs was to try and hit this goal. So if you look at the -- In contrast to these conditions, if you look at the return to power for the NuScale reactor you're really talking about a benign and a very low probability event.

So the next slide is our last slide, a summary.

MEMBER BALLINGER: I've got to chime in here from a material person.

MR. BOTHA: Yes.

MEMBER BALLINGER: These are precedents in the strict definition of the word, but I am with Dick here, these are accidents for which people are taking active measures to remedy.

You are talking about an event where the operators technically can't do anything, don't have to do anything, so it's different. To use these as precedents, these are just events that occur at which point you get a return to power.

You are talking about a return to power which you actually will allow.

MR. BOTHA: Yes.

MEMBER BALLINGER: Maybe I'm not saying it the way it should be said, but that's a very different

thing. That requires a really different attitude that somebody has commented on, with the staff, with the operating crew, and everything.

MR. BOTHA: Yes.

MEMBER BALLINGER: Because I just don't buy that these are with the -- I look up the definition of precedent, okay, but, you know.

MR. BOTHA: Yes. I think where the two differences, right, and that these, the precedent you are talking about significant consequences is the first difference.

And I think the other difference is material is if you look at events that are really in the weeds in terms of low probability, if they are low probability and low consequences do you want to do additional things to the design to try and address that.

(Simultaneous speaking)

MEMBER BALLINGER: Well I'm not saying you shouldn't, that it wouldn't work just fine.

MR. BOTHA: Sure.

MEMBER BALLINGER: I am just saying that I am wondering whether using these as precedents is the right way to --

PARTICIPANT: I agree.

MR. BOTHA: I understand.

MEMBER BALLINGER: -- you know, explain it to people.

MR. BOTHA: You're not comparing apples to apples at this point.

MEMBER BALLINGER: No.

MR. BOTHA: I understand.

MR. SCHULTZ: And another part of that is that when you display it and so the probability is to make an argument that in comparison you have low probability, low consequence.

MR. BOTHA: Yes.

MR. SCHULTZ: Part of that is certainly true, but there is a lot more than just the probability of the event that was considered in the evaluation and the determination of actions taken.

MR. BOTHA: Sure.

MR. SCHULTZ: So you have to explore a lot more to make a precedent comparison.

MR. BOTHA: Yes.

MR. SCHULTZ: And I know you have done that, but --

MR. BOTHA: Yes.

MR. SCHULTZ: -- be careful when you display it as if it were because of the probabilities and that you make a conclusion that the NuScale design

is in a particular position with the comparison to them.

MR. BOTHA: Sure. Thank you.

MEMBER SUNSERI: Well I would say it a little differently, I would say to use as precedents return to criticality is that potential result in core damage is not a condition to your argument because your argument is return to criticality is a non-event.

MR. BOTHA: That's correct.

MEMBER SUNSERI: It doesn't result in core damage, it doesn't even come close to challenging the cladding or the fuel or anything. So I would continue to argue that you are controlling reactivity by the nature of your design versus physical active systems.

MR. BOTHA: Thank you. So in summary, so we have elected to use a safe layer control, control rods as our primary reactivity control system, and that is well suited to our design and the characteristics of our design and that provides us with capability to rapidly shut down the reactor to protect the fuel.

It is also able to reliably maintain the reactor subcritical under cold conditions and then, lastly, the passive features of the design and the inherent features of the design provides for protection against malfunctions in your control rods, even malfunctions in multiple rods.

And then the last two points there is we designed our system to be aligned with the advanced reactor policy statements and with the goals of that statement, and then, lastly, a return to power as we have described as a benign event with a very low probability that is lower than the CDF frequency that is predicted for licensed reactors. Thank you.

CHAIR CORRADINI: Are there questions by the Staff?

MEMBER MARCH-LEUBA: Yes.

CHAIR CORRADINI: Jose?

MEMBER MARCH-LEUBA: I am going back to Dennis's thing. I think this meeting went the wrong way. You intend to convince us that if we give you, if the Staff gives you a pass on GDC 27 it would be okay with you.

We should be discussing whether it is okay to give a pass on GDC 27 whether it is okay with you or not. But with that said, are you going considering reassigning the control rods, put a little more bite on the control rods so you don't have to deal with this? I mean -- Go.

MS. CALLAWAY: Allyson Callaway here. We have looked at different control rod materials, control rods that span more of the core, I guess those are the

two major things that we have considered, and those options don't provide any extra shutdown capability --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: Your rods are black.

MS. CALLAWAY: -- we still have a stuffed rod.

MEMBER MARCH-LEUBA: Your rods are already black.

MS. CALLAWAY: Yes.

MEMBER MARCH-LEUBA: Anything with core loading or, I mean I wouldn't change the length of the cycle?

MEMBER KIRCHNER: Or reducing the work of the assembly. Put more assemblies in.

MEMBER MARCH-LEUBA: And making your cycles shorter will get rid of this, too, but, obviously you don't want to do that.

MS. CALLAWAY: There are ways that we can either cause the event to occur over a smaller portion of the cycle or reduce the disparity of it, but it's --

MEMBER MARCH-LEUBA: It's more important -- It has to be zero or you have to go through the whole thing?

MS. CALLAWAY: Right. Yes, there wasn't something that was obvious that was going to make it

going away and evaluating those things determined that it wasn't necessary based on our design principles to be designing for that.

MEMBER MARCH-LEUBA: Okay.

CHAIR CORRADINI: Other comments?

(No audible response)

CHAIR CORRADINI: Okay. So this is a perfect time to take a break. I'll have you guys exit and have the Staff come on. Let's take a short break till about 20 of and we'll have the Staff come and talk about criteria.

(Whereupon, the above-entitled matter went off the record at 2:25 p.m. and resumed at 2:39 p.m.)

CHAIR CORRADINI: Okay, let's get started. We have the Staff up, or some elite core set of the Staff. Jeff, do you want to --

(Simultaneous speaking)

MEMBER STETKAR: Turn your mic on.

MR. SCHMIDT: Hello, this is Jeff Schmidt from Reactor Systems. I guess, you know, what I found interesting in the discussion with NuScale, is, you know, before I start my formal presentation, was a lot of the discussion you guys had was the same discussion the Staff had over months of time, so it was kind of interesting to hear everybody's perspective.

Again, I am Jeff Schmidt and I am going to talk about the NuScale exemption request to General Design Criteria 27.

MEMBER BLEY: Hey, Jeff?

MR. SCHMIDT: Yes?

MEMBER BLEY: Not to catch you off guard before you get started --

MR. SCHMIDT: That's fine.

PARTICIPANT: Uh-oh.

MEMBER BLEY: You heard some discussion about appearances and the like, why aren't you guys urging them, didn't you guys urge them to request an exemption to some of the guidance on meeting the GDC rather than an exemption to the GDC, which they say they are not doing, they say they are meeting the language of the GDC, your paper in the end essentially says the same thing, why did you do it the way you did?

MR. SCHMIDT: I mean do you have a specific, like what guidance you are referring to? You mean like the SECY papers or -- I'm not sure what --

CHAIR CORRADINI: Green light again, Dennis.

MEMBER BLEY: The GDC simply says that after all those things they have to maintain, the capability to cool the core is maintained. To cool

the core everything about --

MR. SCHMIDT: Reliably controlling reactivity --

(Simultaneous speaking)

MEMBER BLEY: -- being fully shut down, having been fully shut down comes from guidance for a so-called precedent.

MR. SCHMIDT: That is correct.

MEMBER BLEY: It doesn't come from the GDC itself.

MR. SCHMIDT: I think if you take the GDC only within itself it could, the reliably controlling reactivity, and I kind of get into this in the presentation, that term, the reliability controlling reactivity, and I heard it here during the discussion, is somewhat of a nebulous term.

MEMBER BLEY: What?

MR. SCHMIDT: Reliability controlling reactivity, whether that meant, you know, does reactivity such that it equals the heat removal capability, that could be one interpretation, and I think that's what the NuScale interpretation is. The reactivity control --

(Simultaneous speaking)

MEMBER BLEY: Reliably controlling

reactivity changes.

MR. SCHMIDT: Changes, right.

MEMBER BLEY: Yes.

MR. SCHMIDT: Right.

MEMBER BLEY: Go ahead though where you were going.

MR. SCHMIDT: Well I think that's the -- So those were the words that were I think closely in play here.

MEMBER BLEY: Okay.

MR. SCHMIDT: So that meant shut down or not shut down. So if you look at it just in terms of those words I can understand where you are coming from.

But if you look at it relative to say other guidance and precedent then reliably controlling reactivity in the long term, it's interesting, you have to separate out the short term and the long term here.

MEMBER BLEY: Yes, and how do you do that?

(Simultaneous speaking)

MEMBER BLEY: Everything I read talked about that on both sides. Tell me what short term means. Honest, tell me what it means.

MR. SCHMIDT: Yes. Short term effectively means during the active, one way to say it, during the active part of the transient, right.

It means within say seconds of the transient, of the initiation of the transient.

In the long term what we were trying to do is say, you know, the current fleet effectively goes sub-critical at some point and stays subcritical and goes on their residual heat removal or shutdown cooling.

So as was pointed out in the discussion and as was pointed out in this presentation is that there has been some precedent for PWRs to go recritical in the short term for like a main steam line break, right, a postulated accident.

MEMBER BLEY: For sure.

MR. SCHMIDT: So this is somewhat unchartered territory that it would stay potentially in the critical configuration assuming conservative assumptions.

So there is no hard-and-fast short and long term. One is like during the active part of the transient and one is effectively its natural equilibrium condition in the long term.

MEMBER BLEY: Go ahead.

MR. SCHMIDT: Okay. Well, I almost got through the purpose. The purpose is to brief the ACRS on the acceptance criteria the Staff plans on using to evaluate NuScale's exemptions to General Design

Criteria 27, Combined Reactivity Control System Capability, as described in the draft Commission paper.

So a little technical background. NuScale covered a lot of this so I'm going to go through it relatively quick. Late in the pre-app the Staff learned that the NuScale --

MEMBER KIRCHNER: Can I stop you there?

MR. SCHMIDT: Sure. I guess I --

(Simultaneous speaking)

MR. SCHMIDT: Okay, all right, I'm going to stop.

MEMBER KIRCHNER: So what do you mean by late in the pre-application?

MR. SCHMIDT: I mean --

MEMBER KIRCHNER: The Staff learned that, or did NuScale learn that --

MR. SCHMIDT: I can't speak for --

MEMBER KIRCHNER: -- when they did the analysis that it could return to power?

MR. SCHMIDT: It was -- Tim, memory, months before the application?

MR. DRZEWIECKI: Yes, it was during a discussion I thought of the gap letters associated with GDC 27.

MR. SCHMIDT: So that would be months you

would say before the --

MR. DRZEWIECKI: Yes, months before.

MR. SCHMIDT: Months before the application?

MR. DRZEWIECKI: Maybe six months.

MEMBER KIRCHNER: Well I'm just curious when the design team at NuScale or you in reviewing found out that this system would return to power, or did they know that from the get-go?

MR. SCHMIDT: Honestly, you'd have to ask them.

MEMBER KIRCHNER: Okay.

MEMBER MARCH-LEUBA: Can I ask them?

CHAIR CORRADINI: Yes.

MEMBER MARCH-LEUBA: Is anybody close to a microphone?

MR. BERGMAN: As Allyson noted we were trying to solve it through design.

CHAIR CORRADINI: And you are?

MR. BERGMAN: Oh, sorry. Tom Bergman, NuScale. We were trying to solve it through design for quite some time, I would say half a year to a year, when we realized there was really no desirable or workable design solution.

We decided to pursue the approach we have

taken in the application and I think we informed the NRC Staff maybe May of 2016, because we submitted our letter I think in June of 2016 on the topic.

MEMBER MARCH-LEUBA: Thank you.

MEMBER KIRCHNER: So we're backing into this so to speak?

MR. SCHMIDT: I guess from the Staff's perspective --

MEMBER KIRCHNER: I'm not being pejorative, but I'm just thinking, you know, I'm thinking back to the SECY papers that we were provided for background and such and I would be interested, because you fielded a question from Dennis about reliability control, how you define that.

Is there any technical guidance that -- Are you going to share that in your presentation, maybe I shouldn't be interrupting?

MR. SCHMIDT: No. So --

MEMBER KIRCHNER: What does the reliable word in that GDC mean to you?

MR. SCHMIDT: Well that's the thing we had to figure out, right.

MEMBER KIRCHNER: Okay.

MR. SCHMIDT: And what the presentation goes through is kind of how we got to the position and

our response, in the gap letter response, is that, you know, in the long term subcriticality is reliably controlling reactivity.

MEMBER KIRCHNER: Because I mean it was implied but it's not anywhere in the GDC, for to the GDCs that exist now. It's not really well spelled out in any of the SECY papers.

There is the EPRI advanced reactor, advanced LWR, what was it called, I think a utility requirements document or something?

MR. SCHMIDT: Utility requirements document.

MEMBER KIRCHNER: Yes.

MR. SCHMIDT: Right.

MEMBER KIRCHNER: And there they defined safe shutdown as it could be hot, not necessarily cold.

MR. SCHMIDT: Right, not necessarily cold.

MEMBER KIRCHNER: Right. But it implies subcritical?

MR. SCHMIDT: Right. And we'll cover that, it's SECY-94-084. So when we were trying to wrestle --

MEMBER KIRCHNER: I'm sorry, I just wanted to establish is there some regulatory guidance, some body of literature that you go to to define reliable

and safe shutdown or it's --

MR. SCHMIDT: Nothing that we could find.

MEMBER KIRCHNER: Okay.

MR. SCHMIDT: We had to construct it.

MEMBER KIRCHNER: Okay. Thank you.

MR. SCHMIDT: So, again, from the first bullet there, I think the key wording there is "under Chapter 15 design basis assumptions."

You heard this morning from, or afternoon, form NuScale kind of what the expectation is kind of in a realistic mode. You know, I am a Chapter 15 person so I am going to look at this more from a design basis standpoint with design basis assumptions.

So that's a fundamental difference I think between what I am going to talk about and what they talked about, just to keep that straight.

So in my world assumptions include a stuck rod, which is consistent with the GDCs, loss of AC power, non-safety related CVCS system is unavailable. I don't credit it to mitigate a design basis event, and then sufficiently negative MTC.

You know, there is -- In their minds it occurs maybe only in the last third of the cycle, it depends on what your MTC value is, it depends what your stuck rod worth is, those are all core design dependent.

If you take a conservative MTC it can occur earlier.

So using design basis assumptions, return to power following most AOOs and postulated accidents that will occur for the long term.

MEMBER BLEY: Jeff?

MR. SCHMIDT: Yes?

MEMBER BLEY: The Staff has not -- This is an assumption on my part, or I'll change it, has the Staff as yet analyzed the Chapter 15 results that the Applicant is quoting here? You don't have great confidence in --

MR. SCHMIDT: We are reviewing them.

MEMBER BLEY: You are --

MR. SCHMIDT: We are in Phase 1 of the review.

MEMBER BLEY: Okay. But you haven't been through it yet so you can't confirm their answers are --

MR. SCHMIDT: We have not completely been through it.

MEMBER BLEY: -- correct just yet?

MR. SCHMIDT: No.

MEMBER BLEY: Okay.

CHAIR CORRADINI: And you probably have RAIs?

MR. SCHMIDT: Yes.

CHAIR CORRADINI: Okay, yes.

MEMBER BLEY: All right, yes.

MR. SCHMIDT: Yes. We have issued RAIs, yes.

MEMBER BLEY: Okay.

MR. SCHULTZ: Jeff, is the review going to include staff calculations?

MR. SCHMIDT: Yes, that's the plan. I think in one coming slide it talks about confirmatory runs.

MEMBER KIRCHNER: Can I interrupt again?

MR. SCHMIDT: Sure.

MEMBER KIRCHNER: I am just looking at -- There it is. Just that bullet there, "using design basis assumptions," "following most AOOs and postulated," they all a have return to power, not just this one --

MR. SCHMIDT: It's not a single event like say at a normal PWR main steam line break. It's when they go on the decay heat removal system, depending on your assumptions, they can go recritical until the ECCS batteries wear out or if you assume no power at time zero when the pass of blocks initiate ECCS.

MEMBER KIRCHNER: Okay.

MEMBER BLEY: Now from the Staff's point

of view the AOOs don't need to meet the design basis assumptions, right?

MR. SCHMIDT: No, they do.

MEMBER BLEY: They do?

MR. SCHMIDT: AOOs use design basis assumptions. AOOs and postulated accidents are design basis events and use the same conservative assumptions.

MEMBER BLEY: Okay. AOOs, too, okay.

MR. SCHMIDT: Yes. Maximum return to power is roughly around 9 percent and peak pin power due to the fact that we have this stuck rod is greater than 50 percent, so you have a highly localized power distribution.

Design remains subcritical if all control rods insert. Again, we have not verified that, that's just a statement and you heard it this morning from NuScale. Go ahead, next slide.

CHAIR CORRADINI: So since you have done this from the world of Chapter 15 --

MR. SCHMIDT: Yes?

CHAIR CORRADINI: -- there is a time of "X," "X" could be an hour, minutes, I don't even know what it is, where I am on a cool down curve and I haven't gotten there yet and then I come back to a return to power.

MR. SCHMIDT: Right. That's what will happen. I think you'll go down, you'll basically cool down, and when you get enough positive reactivity from the cool down you will return to power and return to a new equilibrium state with fission power.

CHAIR CORRADINI: Okay.

MEMBER BLEY: Jeff, I am going to ask you something, and you can tell me to wait on this, because in the paper we read, you have a phrase that said, and this is okay, you've given something, "and provided the DBE sequence of events is not actually expected to occur during the lifetime of the module."

Now AOOs are expected to occur once in 100 years.

MR. SCHMIDT: Right, sure, right.

MEMBER BLEY: But design basis events are not.

MR. SCHMIDT: Well postulated accidents are not.

MEMBER BLEY: Postulated accidents are not?

MR. SCHMIDT: Right.

MEMBER BLEY: But we're having the same situation for both AOOs and design basis events.

MR. SCHMIDT: Well we're trying to get

there. I am not sure exactly -- Are you reading from my slides or --

MEMBER BLEY: No, I'm not. I am reading from the draft --

MR. SCHMIDT: Oh, the draft SECY paper?

MEMBER BLEY: SECY, yes.

MR. SCHMIDT: So I think -- I'm not sure exactly what you reading but I am going to try --

MEMBER BLEY: I can read it to you if you would prefer it.

MR. SCHMIDT: The basic is if you look at it from say a probability event it's not expected to happen in the lifetime of the plant, right, and those PRA numbers have to be re-reviewed and agreed upon, right.

That's really what we are saying there is that that is part, it's not part of the Chapter 15 evaluation --

MEMBER BLEY: Yes.

MR. SCHMIDT: -- we assume that the probability of occurrence is one from Chapter 15.

MEMBER BLEY: Right, from Chapter 15.

MR. SCHMIDT: From the exemption standpoint we are going to look at the consequences and the probability of occurrence.

MEMBER BLEY: Okay. So that would then mean the AOOs with a stuck rod really aren't AOOs anymore, they're rare events, is what you are going to require?

MR. SCHMIDT: Yes. Well --

MEMBER BLEY: And that's a reasonable thing it seems to me.

MR. SCHMIDT: You got to separate out Chapter 15 from the exemption.

MEMBER BLEY: Yes.

MR. SCHMIDT: So a stuck rod is always taken in a design basis event and it will be taken in Chapter 15. The exemption, which includes other considerations, would effectively move the probability outside of an AOO to something like a postulated accident.

MEMBER BLEY: Normal definition, yes, exactly.

MR. SCHMIDT: Yes.

MEMBER BLEY: That's what I was getting at. Thank you.

MR. SCHMIDT: Yes. But, you know, keep in mind, again, from Chapter 15 the rules of the road are take a stuck rod and it does occur.

MEMBER BLEY: Yes. I understand that

area.

MR. SCHMIDT: Okay. So as -- Do I need to read GDC 27 or can we move --

CHAIR CORRADINI: Yes, let's stipulate you've read it.

(Laughter.)

MR. SCHMIDT: Okay, all right. All right, stipulated. Thank you.

PARTICIPANT: And we can, too.

MR. SCHMIDT: All right. But I mean we have talked about it. It's reliably controlling reactivity changes and the capability to cool the core, those are the words in play on GDC 27, and the Staff struggled with reliably controlling reactivity changes.

So we looked for other guidance. So we looked at SECY-94-084 and basically one of the criteria there is as long as the reactor is subcritical, so that provided us some information.

Go ahead, next slide. And then the definition of a safety-related SCC says ability to shutdown and maintain in a safe shutdown condition. So, again, it didn't say a safety-related component, it says, you know, provide enough such that your adequate cooling is provided, it said shut down.

So taking those two things and in context of what our current licensed fleet looks like that's how we kind of came to the reliably controlling reactivity and the long-term means shutdown.

The NRC has license designs with return to power in the short term during postulated accidents, we have talked about that. NRC has not licensed a reactor that does not achieve subcriticality in the long term using only safety-related systems, and that is important.

Staff's response to NuScale, as we know, is that an exemption to GDC 27 would be required and would warrant Commission consideration and direction. And that is our gap letter response there, the ML1.

PDC 27, I think NuScale has already covered this. It is basically saying, you know, we have reliably controlled reactivity sufficiently that we have that matches our cooling capability and, hence, we are going to meet our fuel design limits, our SAFDLs. Go ahead.

CHAIR CORRADINI: Can you just go back to that, please. I'm sorry.

MR. SCHULTZ: But then they have added the second potion of it to cover their circumstance.

MR. SCHMIDT: The second portion being?

MR. SCHULTZ: The second paragraph. The first paragraph is stating what is already written in the GDC 27.

MR. SCHMIDT: Right.

MR. SCHULTZ: And then the second part allows them to make the case that all is going to be accomplished appropriately without the, with all of the safety-related equipment, the control rod.

MR. SCHMIDT: Well I think there is two aspects. One is all rods in and it's shut down, and then two is if you have a stuck rod that you have adequate cooling capability such that the SAFDLs are not met, so the specified fuel design limits are not met, or are met and that you haven't violated the minimum critical heat flux. So I think it's two components.

And that last part is saying that, you know, without margin for stuck rods they are not going to return to power.

MR. SCHULTZ: Correct.

MR. SCHMIDT: So it is two components.

MR. SCHULTZ: Right.

CHAIR CORRADINI: Yes, and that's --

MR. SCHMIDT: Yes, it's both components.

MEMBER MARCH-LEUBA: Is now the time to start throwing rocks at this? I don't see that second

part of having anything to the general design criteria.

CHAIR CORRADINI: But that's their design criteria.

MEMBER KIRCHNER: Yes, that's their principle design criteria.

CHAIR CORRADINI: This is their PDC, not the GDC.

PARTICIPANT: This is not the GDC.

MR. SCHMIDT: Yes, yes.

MEMBER KIRCHNER: That's the new one from, the NuScale is part of the --

(Simultaneous speaking)

MEMBER MARCH-LEUBA: This is the one that you proposed?

MR. SCHMIDT: Yes, this is the one I proposed, that's correct.

MEMBER MARCH-LEUBA: I used GDC instead of PDC, but --

CHAIR CORRADINI: Right, right.

MEMBER MARCH-LEUBA: Okay. So I don't see that second part of having anything to do with PDC. It only explains what maintaining the core cool means.

PARTICIPANT: Yes, and exactly right.

MEMBER MARCH-LEUBA: And that typically is then is that in a regulatory guide, or an SRP, and

general design criteria or "P" design criteria are just like the Constitution, you don't mess with them.

And I am certain the people writing the Constitution in the convention, same as the GDC, thought that we are making sausage, but after you then they're really good and I just don't see why -- I mean it doesn't add anything.

MR. SCHMIDT: It does, so --

MEMBER BLEY: It would solve this fight.

(Laughter)

MEMBER MARCH-LEUBA: Well, no, because it's a big stick to change the Constitution.

MEMBER BLEY: What is it, what are you saying?

MEMBER MARCH-LEUBA: So I achieve the same thing with a design rule or an SRP, I will make them pay not a pound of blood, a ton of blood. The SRP should specify every analysis they can possibly considerably do to make sure that the core is cool and it's going to keep them busy for the next two years but I will not change the GDC.

I would make the second part of a good document, like an SRP, because it doesn't say anything.

MR. SCHMIDT: Well it does say that at least they have all rods in and they are subcritical.

MEMBER MARCH-LEUBA: If they have all rods in then this is identified in the first paragraph 2, and that's what every other reactor does. Now we have to deal with the fact that not all rods came in.

PARTICIPANT: And that statement --

MEMBER MARCH-LEUBA: And you satisfy that one by maintaining the core cool.

MR. DRZEWIECKI: This is Tim. I think what that second paragraph also does is it shows that you have a safety-related system that can hold you in a cold shutdown.

So that would be the only statement that they would have in a licensing document.

MEMBER MARCH-LEUBA: But they don't satisfy.

PARTICIPANT: Are you talking about this?

MR. SCHMIDT: All rods in they do.

PARTICIPANT: Yes.

MR. SCHMIDT: All rods in they do.

MEMBER MARCH-LEUBA: That would satisfy the first part of two and that should -- I don't see the part of having anything other than complication.

MR. SCHMIDT: Okay. Okay, all right.

MEMBER BROWN: This is their DCD.

MR. SCHMIDT: Yes, this is what's in their

DCD.

MEMBER BROWN: Okay. And I guess I would phrase Jose's comment a little bit differently. They are fundamentally not needing the GDC 27 based on our past performance.

They are saying we interpret it differently and, therefore, we want to rewrite it in this form. That's kind of like the Constitution change.

MR. SCHMIDT: I don't think that --

MEMBER BROWN: Let me finish. And they can do that, all you have to do is accept it.

MR. SCHMIDT: Yes.

MEMBER BROWN: That's all you have to do when you approve the DCD. You don't have to try to change the wording and call it PDC 27, it's just what they are going to do to meet, what they feel and they need you to agree to this alternate approach.

That's all it is, it's an alternate approach.

MR. SCHMIDT: It's an alternate approach.

MEMBER BROWN: But don't try to recast the general design criteria into some other health lot of work, that's all. And they can use similar words, just don't call it, you'd just say we're asking for an interpretative alternative to what is stated and this

is what we, this the way we are designing, that's our design principle.

And if you agree to that you have agreed to it. If you didn't have exceptions you wouldn't need rules. You can approve an exception.

MR. SCHMIDT: And I think that is what this is trying to accomplish.

MEMBER BROWN: Yes, unfortunately it makes it sound like you are changing the GDCs.

CHAIR CORRADINI: But maybe this is a -- We're getting to a --

MEMBER BROWN: I'm done.

CHAIR CORRADINI: I don't think this is -- Well, in my mind this is not technical. This is what they own, this isn't what the NRC owns. This is what they are writing down within their DCD that explains how they meet --

(Simultaneous speaking)

MEMBER BROWN: The NRC is going to accept this or not.

MR. SCHMIDT: Yes, the NRC probably will approve this is in some fashion, maybe with modifications, but in the end potentially it will be approving this as part of the DCD.

MEMBER BROWN: I would phrase this as an

alternative approach to needing GDC 27, that's all it's supposed to, casting it into a form of a proposed design criteria.

MEMBER BLEY: If I may I'll remind everybody that in a month or two we're going to see the advanced reactor design criteria.

MR. SCHMIDT: Yes.

PARTICIPANT: But I think this is --

MR. SCHMIDT: I was just about to print that up is that, you know, we're going to be seeing a lot of this as alternatives are going to show up in PDCs, right, that's the whole ARDC construct, right.

PARTICIPANT: Yes.

MR. SCHMIDT: So this is a precursor to hopefully future events.

MEMBER KIRCHNER: You think you saw it once you're going to see it again?

MEMBER MARCH-LEUBA: For the record I don't like it there either.

(Laughter)

(Simultaneous speaking)

MEMBER KIRCHNER: Yes, because it goes back to reliability. I believe, and now this is probably not in line with our meeting today, but if I read the advanced reactor design criteria they want

to strike the word "reliably controlling reactivity."

MEMBER MARCH-LEUBA: Well let's not talk about all that.

MEMBER KIRCHNER: Yes, I'm not -- So I wouldn't go there because that is a significant change from the GDCs that they are using to look for an extension.

MEMBER MARCH-LEUBA: The way I see it all the other reactor operators, including myself, have decided to go the cheap way to modify, to approve GDC 27, which is we go through critical, the core is cool.

That's a surrogate for reliably controlling reactivity so the core remains cool which is what they do with the stuck rod. They still control their activity, they put it down and whenever they have more time they will put more water.

And they have to demonstrate that the core remains cool. It is going to cost them a lot of effort. I mean I want to make sure they pay for not going the cheap way, but it doesn't preclude it.

MR. SCHMIDT: I want to try to summarize what you are saying is that if -- So subcritical is the easy path in your mind?

MEMBER MARCH-LEUBA: Yes.

MR. SCHMIDT: I'm not going to argue that.

If you are going to say power versus cooling capability that's more complex. I agree with that, too.

MEMBER MARCH-LEUBA: And it's the same criteria. Now we can write an SRP that makes their life miserable or now going the cheap way, but I don't think -- In my opinion changing the Constitution is a, it's in the news now, it's nuclear option.

MR. SCHMIDT: So I think to be fair the issue is is the Constitution is poorly worded in this case or confusing or can be read multiple ways.

(Simultaneous speaking)

PARTICIPANT: Purposely so.

MEMBER MARCH-LEUBA: -- three pages on the SRPs using new handbook, right?

PARTICIPANT: Right.

MR. MONNINGER: So, Jeff, this is John, John Monninger from the Staff. So with regards to the GDC it's interesting where you look at the applicability of them to comparable light-water reactors versus non-light-water reactors.

I'm 99 percent sure within the requirements for NuScale they have to address the applicable of the GDC because they are a light-water reactor and they are then viewed as generally applicable.

There is some language in there in that

regards and they are allowed to take alternatives to it and they would come forth with the PDC. You know, even though it is potentially the Constitution, the broader Constitution of the Atomic Energy Act and all the regs allow them to take departures, which they would potentially be doing.

Now if you were to look at non-light-water reactors or advanced reactors, which we have engaged with ACRS, it's a different approach, there is the Reg Guide out there.

And they would not need an exemption to follow the ARDC and Reg Guide because the requirements within Part 50 don't explicitly say that the GDC would apply to those types of designs.

So, therefore, you could use the different Constitution, the Reg Guide, the ARDC, and not need an exemption for non-light-water reactors. Here you do because of the terminology within Part 50. So I'm not sure if that helps or not.

MEMBER MARCH-LEUBA: I would have to read the Part 50, but my claim is that the design they showed me a moment ago is likely to satisfy GDC 27 as written. That's what I'm coming up.

PARTICIPANT: Yes.

MEMBER MARCH-LEUBA: And, therefore, my

opinion is making demonstrative on making their live miserable, demonstrating it, make sure we are sure that it does, but if it does -- That second paragraph doesn't tell me anything.

MR. SCHMIDT: Okay.

MR. SCHULTZ: Jeff, the reason I brought up the second paragraph originally was that when I read it it sounds like the statement that satisfies GDC 26 and the first paragraph, with only one phrase missing, which isn't applicable to NuScale, satisfies GDC 27 as written.

MR. SCHMIDT: Right.

MR. SCHULTZ: So I am trying to understand the element that says this is the exemption request.

MR. SCHMIDT: Again, the exemption request is basically subcriticality in the long term, that's the exemption request, right.

MR. SCHULTZ: And I read the second part, it says, the last sentence of GDC 26 says, which is without the stuck rod I am good. Does it not? Am I misreading it?

MR. SCHMIDT: Um --

MR. SCHULTZ: I've got margin for stuck rods, so they are capable of holding it's rods subcritical without margin for stuck rods. That's the

same as this last sentence in GDC 26, which NuScale has said from the beginning that they meet.

MR. SCHMIDT: The last sentence in GDC 26 is to --

MR. DRZEWIECKI: "One of the systems shall be --

MR. SCHMIDT: Is "shall be capable of going to cold shutdown."

MR. SCHULTZ: Yes.

MR. SCHMIDT: And their CDCS system is --

MR. SCHULTZ: Subcritical into cold condition.

MR. SCHMIDT: -- capable of doing that.

MEMBER SUNSERI: I think these words are going to become relevant when you get to your three criteria that you are going to specify for what is an exceptional exemption on this topic.

PARTICIPANT: Yes.

MEMBER SUNSERI: Because I am reading ahead, on Slide 9 you are actually, we'll actually get to see the three criteria that you want to see met for the exemption, right?

MR. SCHMIDT: Yes, right. And some of the wording -- So that is correct. And some of the wording in the PDC may change. I am just showing what is

currently proposed in the PDC.

So I think this is all very valuable feedback, but I think the basic idea is that, and NuScale could speak if I don't capture it correctly, is that, you know, you are matching the power to the heat removal capability, right, and you are showing that your SAFDLs are met.

CHAIR CORRADINI: But I guess I am not -- You guys, I view what you are talking about is a bit more legal. I see the first paragraph saying that I am matching power to cooling and the second paragraph saying that even so I still got to show I don't exceed critical heat flux locally.

That's all it says. That's the technical measure that even though power to flow matches, or power to, heat production equals heat rejections, I still might be in trouble if I exceed critical heat flux.

MR. SCHMIDT: Well critical heat flux is necessary to be met in the N minus 1 configuration or the stuck rod.

MR. SCHMIDT: Right.

PARTICIPANT: Right.

CHAIR CORRADINI: Then maybe I am like Steve I am misreading that second paragraph though. No?

MR. SCHMIDT: Let's just say right now that's what they are proposing --

CHAIR CORRADINI: Okay, fine.

MR. SCHMIDT: -- and we might have to work on that.

CHAIR CORRADINI: But I do think that Matt said it best is this is a setup for the three things you are going to look at very specifically to see if they meet from a criteria standpoint as a go/no-go.

MR. SCHMIDT: Right, that's correct.

CHAIR CORRADINI: Okay.

MR. SCHMIDT: Yes, I think, I hope my slide will be clear.

CHAIR CORRADINI: Okay.

MR. SCHMIDT: Go ahead, next. Again, this is from NuScale. This exemption will not impact the consequence of any design basis event, will not create any new accident precursors.

The NuScale plant incorporates reactivity control provisions to assure the capability to cool the core is maintained under postulated accident conditions and to reliably and safely shutdown the reactor.

Therefore, an exemption will not present and undue risk to the public health and safety. That

is kind of what they presented this morning.

So this is the Staff's review approach. The Staff applied the Enhanced Safety Focused Review Approach, or ESFRA, at the beginning of the review and they did identify this issue as requiring more emphasis in terms of review and scope compared to a traditional review using the ESFRA tool.

So it was kind of like what Jose was saying, it was like, you know, if you're subcritical it's kind of easy, if you are not it gets more complicated, and that's where we are, and using this tool identified that issue early on as soon as we became aware of it.

Staff is early in the review of the analysis, which is the Phase 1 review, and continues to apply the ESFRA in its review.

Technical audits of NuScale analyses is ongoing, and as well as the confirmatory analyses. So we do plan on performing confirmatory analyses for this event.

Here is the Staff's review and acceptance criteria. Chapter 15, again, we talked about it already, conservative analysis assumptions, worst stuck rod, and using the minimum critical heat flux ratio as the acceptance criteria to demonstrate adequate cooling and to maintain the fission product

barrier, being the clad.

This is consistent with methodology typically used to analyze PWR main steam line break, the short-term return to power. It does not consider the probability of occurrence so the probability is one.

The exemption will consider the Chapter 15 criteria I just discussed above, shutdown is maintained assuming all rods are in, because that would seem to be necessary, the probability of occurrence is low, not within the lifetime of the module, and NuScale presented some values for probabilities this morning.

MEMBER STETKAR: Jeff?

MR. SCHMIDT: Yes.

MEMBER STETKAR: When I read through this, convince me where you're going to address stable long-term core heat removal given some equilibrium core power, which might be anywhere from zero to non-zero. Because I don't see you addressing that here.

So, supposed on that, pick some number. You know, 2.73 megawatts or .16 megawatts positive core power. And I'm sitting there, and as we said earlier, and I'm sitting there and I'm cooking.

Where do your criteria for the exemption

address the fact that I need to be able to sit there without running out of water and without running out of heat removal. Not short-term SAFDLs and not --

MR. SCHMIDT: Yes. Well, we're applying the SAFDLs in the long-term. Yes. So there is really two basic scenarios.

MEMBER STETKAR: Okay. If that's --

MR. SCHMIDT: Yes.

MEMBER STETKAR: Okay.

MR. SCHMIDT: Yes, so there's two basic scenarios, at least the way I think of it is, one, is you have the decay heat removal system. That's driving your cool down. It's kind of aux feed and --

MEMBER STETKAR: Take that to 67 hours.

MR. SCHMIDT: Right. So --

MEMBER STETKAR: -- decay heat.

MR. SCHMIDT: Well, at some point the batteries would support those systems --

MEMBER STETKAR: I'm at 67 hours and I'm cooking at some non-zero core power level.

MR. SCHMIDT: Okay. But at 67 hours you have effectively depleted your batteries and gone on ECCS, and then you evaluate the SAFDLs under the ECCS scenario.

MEMBER STETKAR: As long as what you said

initially, that the SAFDLs need to be maintained ad infinitum --

MR. SCHMIDT: Right.

MEMBER STETKAR: -- them I'm okay. Because that should --

MR. SCHMIDT: Well, ad infinitum is a long time but, it's in the long-term. Yes.

MEMBER STETKAR: Until --

MR. SCHMIDT: So it's under both modes.

MEMBER STETKAR: Okay. As long as that's the interpretation because I didn't read that, I read it as --

MR. SCHMIDT: It's intended to be in both modes.

MEMBER STETKAR: Okay.

MR. SCHMIDT: Both on the decay hear removal system and on the ECCS system.

MEMBER STETKAR: Okay. Okay, thank you.

MEMBER MARCH-LEUBA: I guess in the long-term, what we're going to, is that we have some kind of requirement on availability of passive cooling water in the pool, which we know is humongous, but at least there has to be an evaluation.

MEMBER STETKAR: That will get to FLEX though.

MR. SCHMIDT: Yes that's actually, I'm looking at it in terms of a module and a module to drive that pool dry --

MEMBER MARCH-LEUBA: If you lost AC power you're likely to have lost power for all of it.

MEMBER STETKAR: I think 12 modules.

MR. SCHMIDT: But, you could.

MEMBER STETKAR: But 12 times --

MR. SCHMIDT: But even that --

MEMBER MARCH-LEUBA: You have to survive 12 --

MR. SCHMIDT: Okay, so that's, again, if you have --

MEMBER MARCH-LEUBA: One and a half megawatts.

MR. SCHMIDT: If you, yes right, if you believe what NuScale is telling us, that's 30 days out. I think you can restore power within 30 days or that's the case they have to make I guess. But --

MEMBER STETKAR: As long as you're going to ask them to make that case. That's what I was hanging up on.

MR. SCHMIDT: Okay.

MEMBER STETKAR: Because, again, this meeting, as Mike keeps reminding us, was to examine

whether your criteria were adequate. And that's the only thing that I could stumble over in the criteria that I was kind of hanging up on. Because to me they sounded --

CHAIR CORRADINI: Short-term.

MEMBER STETKAR: Short-term.

MR. SCHMIDT: Yes, go ahead, Tim.

MR. DRZEWIECKI: No --

MR. SCHMIDT: Yes, it wasn't meant to be the short-term like you think of a Chapter 15 accident analysis, it was a long-term cooling analysis. But I'm not --

(Laughter)

MR. SCHMIDT: Yes. Well there actually are, there are parts of the long-term cooling analysis that reference back to Chapter 15.

But I think that's a fair comment within the scope of the 30 days. So, I think that's something we have to think about.

MEMBER STETKAR: Again, from my perspective, as long as the Staff and the Applicant are on the same page --

MR. SCHMIDT: Right.

MEMBER STETKAR: -- demonstrating this out past whatever short-term versus long-term means --

MR. SCHMIDT: You know, in most of the scenarios there is, you know, saying you stay on decay, the decay heat removal system, you're going to reach some equilibrium power and you can sit there and you can evaluate the SAFDLs for a long period of time.

If you assume, you go on ECCS and you've lost your batteries, you can evaluate the SAFDLs there too. The only thing is, you would run into problems if you did drain the --

MEMBER STETKAR: If you ran out of water.

MR. SCHMIDT: -- in the pool.

MEMBER STETKAR: -- don't drain, boil the water.

MR. SCHMIDT: Right. If the above are met, the Staff anticipates recommending or granting GDC exemption and the approval of the final version. And that's why we put in the final version of PDC 27.

MEMBER POWERS: When you look at these long-term, where you have defined long-term is like 30 days, do you know the materials behavior?

MR. SCHMIDT: Yes. I mean that's, so one of the things we've discussed is, let's say you are sitting at some fission power for a longer period of time, are there any other fuel failure mechanisms that would be not traditionally considered as a SAFDL?

MEMBER POWERS: I'm reminded that you accrue oxygen or hydrogen in the cladding, it losses ductility.

MR. SCHMIDT: Right.

MEMBER POWERS: And here sometimes you're operating at a low power, say a few percent, things are cool so the ductility you gain at normal operating temperature is no longer there.

MR. SCHMIDT: Right. Right.

MEMBER POWERS: And so any kind of event that's strains the clad some more can lead to fracture.

MR. SCHMIDT: Right.

MEMBER POWERS: And I just wondered if you considered that?

MR. SCHMIDT: We are considering different, so, you just described to me a failure mode of the cladding that may be occurring at low power over a long period of time, right?

MEMBER POWERS: Right.

MR. SCHMIDT: So we are considering, are there different failure modes. NuScale's current clad is M5, which has low hydrogen absorption. And so, it benefits them from say any loss of ductility due to a hydrogen pick-up.

But we are considering those --

MEMBER POWERS: That does not exempt them from that.

MR. SCHMIDT: I'm sorry?

MEMBER POWERS: It does not exempt them from that, it is a lower hydrogen pick-up.

CHAIR CORRADINI: He's saying they're not immune to it, it's just less.

MR. SCHMIDT: Yes, right. And I'm not saying it's not immune to it either I'm just saying it has some beneficial properties.

MEMBER BALLINGER: Let me make this a little more complicated.

MR. SCHMIDT: Okay.

MEMBER BALLINGER: If it's a local power area --

MR. SCHMIDT: Yes, it is a local power.

MEMBER BALLINGER: -- hydrogen has a tendency to migrate down the temperature grade.

MR. SCHMIDT: Okay.

MEMBER BALLINGER: So, you're sitting there with your core in a configuration where you've got the normal power distribution and the hydrogen is wherever it goes --

MR. SCHMIDT: Right.

MEMBER BALLINGER: -- but now all of a

sudden, you're in a situation where, yes, it's M5, there's not a whole lot of hydrogen in there compared to Zirc-4, but now you have a different thermal distribution along one of these rods and now you can get the hydrogen migrating down the temperature gradient. So now you can get hydrogen concentrations that may be a lot higher, locally in a spot, where it wouldn't have been that way before.

MR. SCHMIDT: Right. But that's true of any stuck rod configuration, the only difference here is the time.

MEMBER BALLINGER: But we're not talking, a stuck rod is for a couple hours or a couple of days or something, we're talking about very long-term.

MR. SCHMIDT: Right.

MEMBER BALLINGER: So there's another, I mean, I'm trying to --

MR. SCHMIDT: Right.

MEMBER BALLINGER: -- come up with some kind of weird scenario that's not so weird.

MR. SCHMIDT: Right. Right.

MR. SCHULTZ: Jeff, with regard to the considerations, going back to what Dennis asked before, the probability of occurrence, what do you mean by that?

What will be the probability of occurrence,

the occurrence of a stuck rod?

MR. SCHMIDT: No, a return to power. So it includes all the considerations that might lead to a return to power. So stuck rod --

MR. SCHULTZ: Okay.

MR. SCHMIDT: -- MTC, loss of AC power. It's multiple events that lead to the return of power.

MEMBER STETKAR: So as long as, if the lifetime of a module is, pick a number, 100 years, as long as it's nine times ten to the minus three it's okay?

MR. SCHMIDT: That's what we're thinking, yes. I mean, we are wrestling with, not within the lifetime of the module, it's hard to specify an acceptable number. The clearest one was just to say, never to occur and expect the lifetime of the module.

MEMBER MARCH-LEUBA: Changing the topic back to your acceptance criteria. This is not an event that happens after a double guillotine break or an AOO, normal shutdown, because I want to go into maintenance because I need to replace something, well get you into this event?

MR. SCHMIDT: I think NuScale, I'm going to actually turn it over to NuScale because I'm not sure that that's true.

MEMBER MARCH-LEUBA: You tried to shutdown and one rod got stuck?

(Off microphone comment)

MR. SCHMIDT: Well, you have to lose your normal condenser and feed water and --

MEMBER MARCH-LEUBA: Or you lost AC power and you have a scram, okay.

MR. SCHMIDT: Okay. Then you're in AOO.

MEMBER MARCH-LEUBA: Then you want --

MR. SCHMIDT: Yes, then you're right.

MEMBER MARCH-LEUBA: But, data retrieved there for at least 30 days, maybe six months, are we going to have analysis of additional failures?

When we reach up to 15 we have positive activity events.

MR. SCHMIDT: Oh.

MEMBER MARCH-LEUBA: Like the operator tries to take control of the reactor, starts putting really, really cold water in there.

MR. SCHMIDT: Right.

MEMBER MARCH-LEUBA: And now that you have a month or two or three for the operator to mess up --

(Laughter)

MEMBER MARCH-LEUBA: -- can happen.

MR. SCHMIDT: We'll have to consider that.

MEMBER MARCH-LEUBA: It has to be considered because once you're in criticality, any possible reactivity --

MR. SCHMIDT: Sure.

MEMBER MARCH-LEUBA: -- then that's bad.

MEMBER POWERS: Because the operators will do something.

MR. SCHMIDT: I will say this --

MEMBER MARCH-LEUBA: And putting cold water into the core is something one wants to do.

CHAIR CORRADINI: So, can I ask a question so you clearly have gone off the criteria. Do you want to get to this before we go off --

MR. SCHMIDT: I think I'm at the end. Yes, I'm at the end. So let me address your question, is that in most scenarios here that I can at least conceive of, is that you would have adequate decay heat such that you would void the core and be subcritical.

MEMBER MARCH-LEUBA: I agree a hundred percent. But on the ones where you don't, they're all going to be stuck. So that's why I was trying to make the point that we don't really need to have, to waste the afternoon on this exercise. We don't need an exception.

(Laughter)

CHAIR CORRADINI: Since we brought that up, my impression is, in just talking with staff ahead of time, my sense of it is, asking for the exemption is partly to get the attention of the Commission such that they're not surprised that they're a technical design that's not your typical light water technical design, it's just miniaturized.

MEMBER MARCH-LEUBA: If I was invested in their company, which I'm not for the record, I will want them to do that. Because I don't want to have the licensee uncertainty three years from now.

CHAIR CORRADINI: Right.

MEMBER MARCH-LEUBA: You want to address it now.

CHAIR CORRADINI: Absolutely. Did you have more to say?

MR. SCHMIDT: I did not.

CHAIR CORRADINI: So, let me ask you a couple of off-beat questions. If NuScale gets its DCD, it must satisfy the MBDBE Rule, yes?

MR. SCHMIDT: The what rule?

CHAIR CORRADINI: The FLEX.

MR. SCHMIDT: I'm not reviewing that section so I don't know.

CHAIR CORRADINI: Assuming, I sense of it

is yes.

MR. SCHMIDT: Okay.

CHAIR CORRADINI: That would mean I, within 24 to 36 hours, potentially have the ability to bring additional power coupling the water, all that supposedly good stuff on and inject through normal systems.

MEMBER STETKAR: Be careful because you said, for the record, 24 to 36 hours.

CHAIR CORRADINI: I can't remember what the number was.

MEMBER STETKAR: No, some plants have evoked 24, some plants have evoked 72, some plants have evoked seven days I believe.

CHAIR CORRADINI: A few days.

MEMBER STETKAR: I think the max is seven days.

CHAIR CORRADINI: I knew Stetkar would get that. A few days. My only point is, I think leaving it on the record that it's 30 days untouched is not the right way to think of this.

My way of thinking about it is to the extent this is a light water rector, to the extent that the FLEX rule, which I think is mitigation for whatever, all the various consonance together, is that you would

essentially, in a few days, bring things onsite and perform potential actions that would get you this. As low probability as I expect.

MEMBER RAY: My --

CHAIR CORRADINI: Hi, Harold.

MEMBER RAY: Yes, this is Harold Ray. Are you sure that FLEX is intended to apply to new designs like we're reviewing here?

CHAIR CORRADINI: It applies to any new light water reactor design per the original rule. We could ask somebody.

MEMBER RAY: All right.

MR. MONNINGER: So, this is John Monninger from the Staff. So, currently the MBDBE rule is with the Commission so there is no current rule in effect.

CHAIR CORRADINI: Oh, I think it was a task.

MR. MONNINGER: With that said, the Staff has looked at design certs and COLs in the past to see to the extent that they meet the previous orders and requirements and all that kind of stuff.

CHAIR CORRADINI: Okay.

MR. MONNINGER: With regard to the MBDBE Rule, mitigating strategies rule, the applicability is actually for the COL and not the design certification

application.

CHAIR CORRADINI: Oh, excuse me.

MR. MONNINGER: With that said, if the design certification Applicant, such as NuScale, proactively decide to address aspects of it, they could and the Staff would review to the extent we could.

CHAIR CORRADINI: Okay.

MR. MONNINGER: And NuScale is proposing to meet aspects of the proposed rule. And we will review that.

MEMBER STETKAR: And I think, John --

CHAIR CORRADINI: Thanks for clarifying.

MEMBER STETKAR: John.

MR. MONNINGER: Yes.

MEMBER STETKAR: And I think we've seen, correct me if I'm wrong, I think we've seen, what I don't remember is whether it's design certification documentation or whether it's only COLs that establish the coping times. For example, 72 hour coping time. And I don't recall whether it's in the design certification or the COL. COLs.

MR. MONNINGER: Yes. So most of the design certs, besides, so most of the design certs, be it the AP1000, well, the ESBWR, where done prior to that so most of the aspects that the Staff has done

with regards to potential compliance with the orders have been with the COLs.

And generally they've showed, with installed equipment, 24 hours and then with written, up to 70. So there isn't much of a limitation at all with regards to the passive designs. And we've had discussions with NuScale and timeframes are significantly in excess of the current designs.

The current designs may need to be, the passive designs may need to refill a tank or turn on a fan for recombinations but here you don't have that. There is significantly potentially more time for the NuScale design.

MEMBER STETKAR: Thank you.

MEMBER SKILLMAN: Mr. Chairman, I'd like to make a comment.

CHAIR CORRADINI: Sure.

MEMBER SKILLMAN: That at least reflects in whole or in part on your comment. As I understand this design, and we've looked at it for a couple of years now, the construct of the NuScale design is it could be hopefully sited North of Caribou, Maine, it could be sited in Denali in Alaska.

This is a standalone passive machine that can be put almost anywhere. And good luck with FLEX.

This machine is intended to be able to be licensed almost anywhere on the face of the earth that meets the PPE.

And so I think it would be inappropriate for us to be thinking that FLEX would even be a part of this. This machine has got to be able to take care of itself.

And to me, that has some very significant design requirements that back up into their power design, they're non-1E design and the extent to which that translates throughout the entire design.

CHAIR CORRADINI: Right. But the reason I brought it up was, is that I can't imagine an owner/operator would sit there for 30 days knowing that this is how it's doing things, it would bring to bear what it has onsite to essentially take it to cold shutdown.

MEMBER SKILLMAN: Well, that begins with the NSSS designer making sure that it can be brought to cold shutdown.

CHAIR CORRADINI: Other comments? Have you completed your presentation?

MR. SCHMIDT: I have.

CHAIR CORRADINI: Okay. Any questions for Jeff instead of between us, because I want to

continue the discussion as to how we proceed as a Committee. Any questions for Jeff? Okay, thank you very much.

MR. SNODDERLY: This is Mike Snodderly from the ACRS Staff. So before Jeff leaves did you, so right now the next interaction would be on Thursday, February 8th from 8:30 to 10:30, this item is scheduled for the full committee.

CHAIR CORRADINI: Well, what I was going to do at this point is, we don't have anything in closed session, I wanted to get public comments and then discuss what the members comments and how we handle potentially three questions, do we want to do a letter, if we want to do a letter, what's the general conclusions we want to put in it, because I think is not going to be our typical letter.

MR. SNODDERLY: So Jeff and NuScale please standby.

CHAIR CORRADINI: Yes. We're not dismissing you from the room, we're just dismissing you from the front of the table. You can stay there if you want.

MR. SCHMIDT: Okay.

CHAIR CORRADINI: Okay. So, first of all, is there anybody in the room that wants to make a public

comment?

And we have the bridge line open. Is anybody on the bridge line that would like to make a comment from the public?

Okay. So, what I want to get from the Members is your general comments but specifically about the criteria. Because as I understand this, this SECY is going to go in front of the Commission for their information. And you guys have to explain if I got this right.

It's not going to be a notation vote unless one of the Commissioners decide they want a notation vote, it's kind of like an FYI memo. This is where the Staff is going, we want to let you know where we're going and these are the criteria we're going to use to judge the design.

MR. SNODDERLY: Right.

CHAIR CORRADINI: Okay. So have I got that approximately correct?

MR. SNODDERLY: Yes.

CHAIR CORRADINI: Okay. So the question for all of us is, do we want to write a letter about this in terms of saying this is an acceptable criteria for the exemption on GDC 27 or this is not or we really don't think we want to say anything at this point till

we see the design or what? And I'll start with Ron.

MEMBER BALLINGER: I think we need to write a letter. I actually don't think they need the exemption.

CHAIR CORRADINI: Well, okay. And that's all we should say, from your perspective?

MEMBER BALLINGER: I have a bunch of opinions but I'll hold them.

MR. SNODDERLY: I'm sorry, Mike, we didn't unmute the phone, but it's unmuted right now --

CHAIR CORRADINI: Oh.

MR. SNODDERLY: -- so could you please ask again if anyone from the public wants to make --

CHAIR CORRADINI: Oh, sorry. Let's go back to the public comments. Are there anybody on --

MS. FIELDS: Hi. Yes, I have a comment.

CHAIR CORRADINI: Okay, could you please state your name please and then give us your comment?

MS. FIELDS: Sarah Fields, S-A-R-A-H, F-I-E-L-D-S. And I think this issue warrants a lot more discussion.

And having listened to some of the NRC NuScale meetings, I think there are a lot of other issues having to do with the development of this design and the approvals, the responses to RAIs that would impact

this request for an extension. And I think that there are other requests for extensions, other considerations which might have accumulative effects.

I also don't see in this discussion how this relates to how they're considering difficulties in one or more of the modules. If they're just focusing on a one module event rather than multiple module events. Thank you.

CHAIR CORRADINI: Thank you. Is there anybody else on the phone line that would like to make a comment? Okay, hearing none, if we could just mute the line again?

Let's go to our consultant, Dr. Schultz. We'll just go around.

MR. SCHULTZ: Okay, appreciate the discussions today. In reviewing the information available, from both the Applicant and the Staff, even with the presentations today and the information related to the proposal for an exemption, I still do struggle with the benefit that the proposed exemption is going to in fact provide.

And I just go back to the GDCs and the basis for their development and for their application. It's clear that there are issues that are identified here that need to be addressed, associated with long-term

cooling following an event. I just don't see that an exemption to the GDCs is the appropriate way to go to identify them and then to address them.

What the Staff is proposed to do, what the Staff is proposed to do needs to be done in terms of the evaluations and the reviews of what NuScale has developed. But I think the Staff could still conclude that an exemption to the GDCs is not required.

CHAIR CORRADINI: Dr. Bley. Member Bley. Former Chairman Bley. Happily, former Chairman Bley.

MEMBER BLEY: Now you got it. I think we have to write a letter. I think it can be short. And if we want, we could emphasize that we aren't accepting the details here because we'll have to review them later.

In principle, I agree with what the Staff is doing and would support it. And that's the way I would lean. Assuming we write a letter.

CHAIR CORRADINI: Anything else, Dennis?

MEMBER BLEY: No, that's enough.

CHAIR CORRADINI: Dick.

MEMBER SKILLMAN: Yes, sir. I agree with Dennis. I believe that we should write a letter. And I say that with two additional comments.

And that is assuming that a main steam line

break recriticality is an acceptable precedent for arguing that a long-term low power level criticality, in my mind, is not appropriate.

And secondly, accepting a chronic criticality, albeit at low power, with assumed negligible fuel damage, is not consistent with the intent of years of regulatory practice. Thank you.

CHAIR CORRADINI: The first part I've got, I'm not sure I captured the second.

MEMBER SKILLMAN: Accepting a low-level criticality, chronic low-level criticality --

MEMBER POWERS: On the contrary, we're all thinking in reactor safety.

MEMBER SKILLMAN: -- albeit with little or no fuel damage, it's just contrary to years of regulatory practice. Thank you.

CHAIR CORRADINI: Dana.

MEMBER POWERS: Okay, we are, I vote we have an exemption for request and we certainly allow exemptions to the GDC. This particular request does strike at the heart of all reactor safety thinking since the nuclear era began.

The situation is the operator will have lost control of his reactor. Nevertheless, we need to look at the exemption request.

And I rather like what the NRC has laid out for the way they're going to look at it. They have not been effusive in their disclosure, there apparently is much more in what they're going to do than what's written on the slides. We saw that with a little interrogation.

I don't envy the Staff because they're going to have to persuade that they've thought of everything. And that's a lot by the way. But nevertheless, as far as their approach, I rather like it.

I do think it's premature to write a letter until we have seen what the Staff is actually going to approach this.

CHAIR CORRADINI: Premature for us to write a letter.

MEMBER POWERS: For us to write a letter. Premature for us to weigh in on this.

If we do write a letter, then I don't think it's a short one, I think it's a rather lengthy one because there are differences of opinions. And you're not going to write a consensus letter you're going to write a letter that says, here is what all the thinking is on this Committee. And that, I think, cannot be a short letter.

CHAIR CORRADINI: Matt.

MEMBER SUNSERI: Thank you, Mike. At this point of the review I don't see the need to write a letter. Whether there's an exemption to GDC 27 or not seem to me to be an administrative issue.

CHAIR CORRADINI: Can I interject one thing?

MEMBER SUNSERI: Yes.

CHAIR CORRADINI: Just because you guys said the same thing, and so what I'm interpreting you're saying is premature to write a letter on the SECY, which will go up to the Commission regardless?

I want to make sure we're clear. They're going to send the SECY up which says, this is what we're going to do and this is the criteria we're going to do it, and that's the context?

MEMBER SUNSERI: Yes.

CHAIR CORRADINI: Okay. I'm sorry.

MR. SNODDERLY: I'm sorry, Mike, Mike's not really a ACRS Staff. So right now, the draft SECY, and it is a draft, I just want to remind you that there is a placeholder in there right now where the Staff references an ACRS letter.

CHAIR CORRADINI: Yes, well.

MR. SNODDERLY: Well, yes, but that's the

way it --

CHAIR CORRADINI: Okay.

MR. SNODDERLY: -- that's in the public record and that's --

CHAIR CORRADINI: Sure, that's fine.

MR. SNODDERLY: Okay.

CHAIR CORRADINI: I just want to make sure that, because we're all on the same page. Go ahead, Matt, I'm sorry. Excuse me.

MEMBER SUNSERI: It's okay. So, I'll start again. I don't see the need for us to write a letter at this time because whether or not an exemption is used or not seems to me to be an administrative issue associated, we'll get a chance to judge the technical merits of whether this is safe or not safe later on when we review the DCD and the SER and we have more technical details about the design before us than what we've seen to date.

So at that point in time I see that the appropriate time for a letter documenting our technical basis for our decision.

CHAIR CORRADINI: Okay. John.

MEMBER STETKAR: I'm kind of torn, I think we should write a letter. Only to document the fact that we have deliberated on the notion that a reactor

can remain critical producing non-zero power and yet satisfy the basic principles of health and safety of the public.

Because I've read the general design criteria and I will tell you they are not clear. Even in the residual heat removal it says decay heat and other, what does it say, system safety functions shall be to transfer fission product decay heat and other residual heat from the reactor core. So that implies --

CHAIR CORRADINI: Say that again please.

MEMBER STETKAR: Under GDC 34, where I go to residual heat removal, which is where I'm kind of long-term cooling it says, a system to remove residual heat shall be provided.

The system safety function shall be to transfer fission product decay heat and other residue heat from the reactor core, at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant system, reactor coolant boundary are not exceeded. It doesn't say, big enough to takeaway non-zero power.

And that's where I come down to where I think that we should acknowledge that we've deliberated on this and --

CHAIR CORRADINI: And? We've deliberated

and?

MEMBER STETKAR: Well, I don't know what where our deliberation is going to lead.

CHAIR CORRADINI: No. But in your personal opinion, we've deliberated and --

MEMBER STETKAR: In my personal opinion, as long as the Applicant can provide a convincing argument that for the spectrum of things that can happen to this plant, they can successfully remove power from the core, that power could be produced by decay, fission product decay or neutrons, I'm happy. That's what our role is, is protecting health and safety of the public, it isn't for making life easy for operators, it isn't for the news media.

But I think if they're going to send it up I think that the, I personally think the Commission would want us to weigh in on it.

MEMBER BALLINGER: Can I make a statement now to expand upon my three words?

CHAIR CORRADINI: Yes.

MEMBER BALLINGER: I was going to make the heretical statement that the plant cannot only remove decay heat but it can also remove heat from a criticality event. Which is different.

MEMBER STETKAR: And that's my whole

point, is --

MEMBER BALLINGER: Yes, that's --

MEMBER STETKAR: -- that if you just pick and choose from the general design criteria, residual heat removal, or long-term cooling, the way it's written is the presumption that the core is subcritical.

MEMBER BALLINGER: Yes.

MEMBER STETKAR: The other subcriticality thing is what we've been mincing with today.

MR. SCHULTZ: And the other piece is to protect the fission product barriers. Clearly.

MEMBER BLEY: May I too chime back in?

CHAIR CORRADINI: Sure.

MEMBER BLEY: I'm no changing my opinion, I think we ought to write a letter. If that letter turns out to be very complicated I think that's okay. If we can't come to a conclusion, I think that's okay too.

I think the Commission would really want to hear how we're settling out on this. One way or the other or if we can't settle out in one place or not.

MEMBER STETKAR: We've written letters in the past that says, you know, typically we count bodies but, the majority of the Committee felt this way and

a minority or perhaps a couple minorities felt the other way or we were equally split or, and that's useful to the Commission.

CHAIR CORRADINI: Jose.

MEMBER MARCH-LEUBA: I'm going to agree with my friend John, using different words of course.

(Laughter)

MEMBER STETKAR: Yes, but I'm just counting one.

(Laughter)

MEMBER MARCH-LEUBA: Yes. I'm not autographing that page for you.

CHAIR CORRADINI: Okay, thanks.

MEMBER MARCH-LEUBA: After listening to what NuScale had to say about this, it is my belief that they can make a, it's a high likelihood they can make a good case, that they can keep the reactor cool after one of these unlikely criticality events happen after shutdown.

And therefore, and it is my belief that that meets the spirit, if not the letter of GDC 27, and therefore an exception is not needed. Because if, they can make a case.

I don't know if they'll, I mean -- and as I said before, they're going to be sorry they didn't

go the easy way of proving subcriticality. Because it's going to be difficult to make that case. But that case can be made. And if that case is made, then you meet GDC 27, which I think they can do.

And the proposed solution, which is this PDC, just makes no sense to me. That second paragraph is exactly a copy of the paragraph before, in 10 CFR 50, which is GDC 26. Let me read it to you.

Just the paragraph before it says, with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. One of the systems are capable of holding the reactor more subcritical under core conditions. It's the same paragraph with the two sentences reversed.

So even if we were to issue an exception, the solution, the remedy, doesn't fix anything. It doesn't have anything that we already don't have.

So in conclusion, I do think that these guys can make a good case and I see a high probability to success. I think I make that case.

But, because there is no regulatory guide or SRP to guide them into how to make that argument, I mean, in all other cases there is established law, you follow that regulatory guide, you know how you have to demonstrate it. Because there is no such thing,

they're going to have to bring, to play bring me a rock.

They're going to make an analysis, they're going to have to bring it to the Staff and the Staff is going to say, this is not enough. Okay. So, it's a risk NuScale is running.

But in my opinion, there is no need to modify what I said before, what I called before the constitution. And I will write a letter on that.

CHAIR CORRADINI: Walt.

MEMBER KIRCHNER: Let me start with a personal view. And it's, I think I'm repeating other's comments, but I think the precedent of a reliable control system suggests that you would bring the reactor to a subcritical state over the longer haul.

I think the collection of GDCs and other supporting guidance that the agency uses points in that direction. And personally, as a designer, I would try very hard to avoid having to even make this exception.

Now having said that, I think under the criteria that, and process that's been laid out by the staff, I can see a way to, validating, granting such an exception. But Jose may be right, the lawyers could read what has been submitted by the Applicant and look at the GDCs and say they meet the letter of the requirements as written.

But I think it would be a bad precedent if we didn't do it through an exemption. Because I'm looking ahead, it would be a bad precedent to have a, I'm looking down the road a little bit. If this is granted to NuScale as an exemption I'm comfortable with that because that means the next person who comes along has to really prove, technically, that they can meet the criteria.

I'm very concerned about what I have seen in drafts of the advance reactor design criteria where they strike things like, well, I will control reactivity. Especially for some of the designs that we know, that are out there.

So, I kind of feel that even if the lawyers could agree that they don't need an exemption, I think the precedent that this sets of having a design that could return to criticality "an uncontrolled manner but designed for that," as an exemption is a better way. And it gives some, I think, surety for NuScale going forward as well.

MEMBER SUNSERI: So, let me make sure I've got your comment because --

MEMBER KIRCHNER: Well, I've rambled a little bit.

CHAIR CORRADINI: -- I've concluded I'm

going to have a little bit of a tough time drafting it. So, you think it needs an exemption, A, we should write a letter about it --

MEMBER KIRCHNER: Yes.

CHAIR CORRADINI: -- but you think the criteria are acceptable?

MEMBER KIRCHNER: I think the process and acceptance criteria for review, laid out by the Staff, assuming the additional information is forthcoming, is a path forward, yes.

CHAIR CORRADINI: Charlie.

MEMBER BROWN: I'll just make the letter harder for you.

CHAIR CORRADINI: Thanks, Charlie.

MEMBER BROWN: No. It won't make the letter hard for folks to understand --

CHAIR CORRADINI: Okay, Charlie.

MEMBER BROWN: -- my personal opinion that once a reactor is shutdown into subcritical it should stay there. The bottom line, it not go re-critical and you should not develop neutron power for days and days, whatever that time may be, whether you think you got it under control or not.

I just don't think it's a good idea and I don't think we should set a precedent of going in

that direction from a reactor design standpoint. A reactor plant design standpoint.

That's my personal opinion. Regardless of the way we want to wordsmith the exemptions.

With the disparate opinions and things, it seems reasonable that we ought to try to write a letter to get the various view points before the Commission when they get the SECY. But we can debate that when we decide to do it or not do it. But we might start and find out it's too hard.

But my fundamental issue is not so much, I'm not necessarily disagreeing with their technical approach and their proposed design criteria they want, I just don't think it's a good idea to sit there.

The longer a plant sits there critical, generating neutron power after its shutdown supposedly, is just a, you're just putting yourself into a position for other things happening, which then complicates the whole situation. You do not have means to take action to control what's going on. That's my personal opinion.

So I guess I would write a letter, but that's my opinion as a throw in on, if I was writing the letter, that's what I would say.

CHAIR CORRADINI: Okay. Vesna.

MEMBER DIMITRIJEVIC: All right. Did I activate it?

CHAIR CORRADINI: No, at the bottom. The very bottom.

MEMBER DIMITRIJEVIC: Sorry. See, you can see that I'm a beginner. Since I was beginning I was trying not to really --

And because I just met this issue in preparing for this meeting, this is my first time. And I also don't really know the rules of engagement, how do we do this.

MEMBER STETKAR: Don't worry about them.

CHAIR CORRADINI: And it's kind of like --

MEMBER STETKAR: This is the pirates code.

(Laughter)

MEMBER STETKAR: There are no rules.

CHAIR CORRADINI: They say it's more like, where it's the fight in the movie and he says, what are the rules, and the first rule is, there is no rules.

(Laughter)

MEMBER DIMITRIJEVIC: Okay. Well, when I start listening to this I was mostly having the impression, why we are discussing this.

Because one of the things is the charging system or safety we would not be discussing this, is

that a true statement? Because in Chapter 15 you will credit injection of the bottom and we would not be sure identify.

So I said, okay, well, what difference makes is charging system is safety or non-safety because for me, as a PRA person, doesn't make a damn difference, it can fail in both cases.

So then I said, okay, if charging system was safety and it failed, we will get, again, to the situation that we have this low-level criticality, right? Right.

So other difference in both the charging safety, we can get to this question.

CHAIR CORRADINI: But they'd be in a happy land with GDC 27.

MEMBER DIMITRIJEVIC: Yes, that's right. So my first impression was they're not really breaking GDC. Because, so that shouldn't be an exemption.

I think they proved they have reliably controlled reactivity to my satisfaction. But then when I listen to Charlie and I say, okay, can I think about something, can I think something in coolant design which can go so much wrong, because here so many things have to go wrong.

They have to have an accident, involve the

cooling, the rod has to get stuck, AC is not there, charging system has to fail, operators have to be dead basically. So, when you look in all of these things which can go wrong, then you said, all right, I mean, this is not going to happen.

But then I start thinking, in the coolant design is something where we can get critical, what can happen that we can get critical. And the only thing I can think about, like start injecting rods or something which we know is not going to happen.

So from that perspective I think that my current position is that maybe this is not exemption but on the other hand, maybe we still have to prove that cooling of the core is maintained in the case that they reach these low criticality.

So, to be honest with you, I mean, I have a feeling that we can write a lifetime, we can write very complex letter. That's obvious with the pages and the pages. See, I am completely unfamiliar with this.

CHAIR CORRADINI: Having to be the one who's going to draft it, I hope not.

MEMBER DIMITRIJEVIC: No. Or we can write some very simply like to say, that's exemption or not exemption, if it's exemption, why is it exemption and

what else they have to do, in our opinion.

And I think, actually, they concentrate on reactivity. Maybe they should concentrate more on core cooling, but maybe they proved that to satisfaction. I mean, I don't really know but I would keep it very simple whatever we do.

CHAIR CORRADINI: Harold, we haven't forgotten California. Has Harold --

MEMBER RAY: It's my strong opinion that we should write a letter. I would refer us to the purpose of our meeting today, which was to review the criteria the Staff will use.

A lot of our discussion has been the criteria that we, ourselves, would use to reach a decision about an exemption or whether one is needed. But I agree with those who see this as an important precedent.

There's a lot to come down the road for us to say we've got nothing to say about the criteria the Staff will use at this time. But we will use our own standard or perspective or criteria, whatever you want to call it, to review it later on. Review the actual outcome, I think would be wrong.

I agree with, I think Walt's point that we need to see ourselves here as, in the beginning of

a process that's going to have a lot of twists, and turns and not just focus on this particular circumstance.

The Staff has concluded that they need an exemption. They set forth some criteria to review it, they've asked us for comment, or at least it's made available to us for comment if we wish to make any, and I think we should make some comment.

Even if it's a very simply letter saying we agree. Albeit we think that perhaps the need for the exemption is something we're not sure of. Or, I don't know, I don't want to suggest what we would say, but my point is, that for us to not write a letter and to simply pass on it I think would be a mistake.

On the other hand, I don't think we should go so far as to opine on what we think is acceptable or not since we were just asked to look at the criteria for granting the exemption.

CHAIR CORRADINI: Okay, thank you, Harold. Okay, so my own personal opinion, but it's part of the majority, is we have to write some sort of letter.

I personally think, Walt I think said it best, that if you think down the road this would, I won't even say appear, I would think this seems to be an inappropriate approach if you had said it doesn't

need an exemption.

This is different enough. There has got to be some discussion as to why it is acceptable although different. If it is acceptable, why it is acceptable although different.

My own personal opinion is, I think they're criteria are reasonable criteria both short and long-term. But I don't sense that that's the unanimous view, so I'd like to get some co-authors to the draft.

Also, you should remember that you all agreed in the retreat that we just don't present a letter, I have to present new graphs to have a discussion again and then we're going to go write a letter. Well, let me tell, we're going to do some things in parallel here, all right.

So I will draft some general statements, because Staff probably didn't realize that but we've changed our letter writing process where we want to have a come to, well, we want to have a discussion in front of the full committee. And we're missing Joy and we're missing, I guess we're just missing Joy. Look at that. Oh, and Pete.

MEMBER STETKAR: Pete.

CHAIR CORRADINI: Excuse me, and Pete.

MEMBER STETKAR: And Margaret.

CHAIR CORRADINI: And Margaret. I'm sorry, it looked like a full table, I forgot. And have a discussion with the full committee.

But I'd like to deputize a few people. It sounds to me like Dick and Charlie are on the same page relative to the inappropriateness of doing this at all.

MEMBER SKILLMAN: I would be glad to.

CHAIR CORRADINI: And if I might get a third person that, I won't say moderate but put it in a context, I'd like to see if Walt could help moderate and give me a paragraph or two. Because I think although it might, I'm going to shoot for a short letter and draft it, I do think Dana's point is fair that if a letter is written, there's going to have to be on the one hand and on the other hand. Okay?

And I think there is one hand here that I want to get from you guys. So can I ask you and Charlie and maybe Walt together --

MEMBER SKILLMAN: Yes.

CHAIR CORRADINI: -- to give me a couple paragraphs on what you view as the appropriateness of it? Okay.

And the other hand, I'd like to get maybe something from our consultant because he doesn't have

to enjoy the thrill of writing the letter.

MR. SCHULTZ: Do you want the view graphs?

CHAIR CORRADINI: No, I don't want you, I simply want your opinion.

MR. SCHULTZ: Understood. You'll get it.

CHAIR CORRADINI: Okay. Because you said I think, and what I took down from you though, is that the criteria do provide, from your standpoint, an acceptable shot at it.

MR. SCHULTZ: That's a part of it.

CHAIR CORRADINI: Okay.

MR. SCHULTZ: But it also feeds into Walt's comments that something has to be done. Whether it has to do with GDC 26 or 27, that's another issue.

CHAIR CORRADINI: Okay. And then finally --

MR. SCHULTZ: I'll get those for you.

CHAIR CORRADINI: -- so that's an assignment, finally, Jose and his good friend John --

MEMBER MARCH-LEUBA: My good friend John has changed opinion so we're in disagreement.

CHAIR CORRADINI: Oh.

(Laughter)

MEMBER MARCH-LEUBA: Yes. It couldn't last.

CHAIR CORRADINI: On the record you were at least in agreement that the criteria were reasonable but it would be a tough sell. I'd like a couple paragraphs on, this is doable based on the criteria, this could be doable based on the criteria proposed by the staff, but it's going to be a tough sell.

MEMBER MARCH-LEUBA: Our point, going to Walt's argument, is we're going to make their life very difficult. They're going to have to pay for this. And so whether there has to be an exception or a lot of analysis, that's got to be done.

CHAIR CORRADINI: Okay.

MEMBER MARCH-LEUBA: And I believe they prefers an exception because they got licensing surety. I mean, assurance.

CHAIR CORRADINI: So, and then the final thing is, I sense we're not going to come down to a consensus. I think this one is important enough that if members want to write something that doesn't fit in with the final conclusion or recommendation, we ought to have added comments. I think the Commission would appreciate that.

MEMBER STETKAR: We can handle that when we write the letter.

CHAIR CORRADINI: I understand.

MEMBER STETKAR: Because we've written letters that within the body of the letter says, on the one hand members believe this and on the other hand they believe that.

MEMBER BLEY: But there is --

MEMBER STETKAR: It doesn't say the consensus, it just says, on the one hand --

MEMBER BLEY: No, no, I'm going to agree.

CHAIR CORRADINI: But I would like to get a conclusion --

MEMBER STETKAR: The added comment -- we can discuss that during the letter writing --

CHAIR CORRADINI: Okay.

MEMBER STETKAR: -- we don't need to discuss it now.

CHAIR CORRADINI: All right. So that's what I thought I have heard and that's what I'd like to do.

So I'm going to get something from Steve, I'm going to get something from Dick and Charlie, with Walt's help, and I'm going to get something from the dynamic duo over here. Okay? All right? Okay.

I think I am happy. What Charlie? I mean, yes, Member Brown.

MEMBER BROWN: In order to do this, I have

a difficult time with my memory locator bits, and so the faster we can get a copy of the transcript so I can see what I said would be very useful.

CHAIR CORRADINI: We will ask the Staff --

MR. SNODDERLY: I've already asked for an expedited transcript.

CHAIR CORRADINI: Okay.

MEMBER BROWN: Okay.

CHAIR CORRADINI: We'll get an expedited transcript.

MEMBER BROWN: Yes, since we've got a short time.

CHAIR CORRADINI: Okay. Yes, we have two lovely weeks.

MEMBER BLEY: If the agenda I just got is correct, this should be the only letter we have.

CHAIR CORRADINI: No, we have the research review letter.

MEMBER BLEY: Oh, that's right.

CHAIR CORRADINI: Which we already have had Draft 3 sent to me.

MEMBER BLEY: Oh. Why is that so hard.

CHAIR CORRADINI: So we do have two letters. And that one is a long one, it's not a shorty.

MEMBER BLEY: But it's easier. Maybe not.

(Laughter)

CHAIR CORRADINI: Okay. All right. With that, I wanted to thank NuScale. Thank you very much for taking the time to come here and give us a good explanation of how this fits into the design. I thank the Staff.

MR. SNODDERLY: Mike, what do you want on February 8th from the Staff and from NuScale, any, I mean, do you want similar types of presentations or --

CHAIR CORRADINI: Well, I don't want to tell them what to do, but I think --

MR. SNODDERLY: No, but --

CHAIR CORRADINI: -- we have two hours.

MR. SNODDERLY: Right.

CHAIR CORRADINI: A portion, an hour for NuScale. I would say that since 12 out of the 15 of us here, you don't have to repeat everything.

I do think you want to walk through at least the general picture, right, of what the design is and where you get into this. Whether it be the best estimate versus the conservative approach and why you, and I think you'll get questions from others, as why you didn't consider a hardware fix or why a hardware fix is not doable given all the other things. Or, an argument that this is better than a hardware fix. But

I think that in that hour.

And then the Staff, I would just say, in a similar vein, try to give us your views on the criteria. If you come up with anything else, I mean, Dana asked a good question that would be relative to long-term failure mechanisms that would pop up that you wouldn't have thought of otherwise. And I think that would be something you might want to consider.

You thought that was a good idea, I'm just going to remind you of it. Charlie.

MEMBER BROWN: Just one other thought for the presentations and the meeting is that I did ask about what you would do if you were direct, if you didn't get acceptance of this and their explanation of the hardware fixes was brief and not very well defined. In my personal opinion, it was sparse.

CHAIR CORRADINI: So you're looking for what exactly?

MEMBER BROWN: If you had to meet what existing plants do, how would you modify the plant in order to do that. And we had a little bit of discussion about reactivity, rods, a few things like that.

But the other choice, I guess, was making the, what it is, the CVCS, the safety system or something like that.

CHAIR CORRADINI: Well then -- so if I might, I mean, my feeling was they should be ready for questions like that, but I don't think it's appropriate for them to start redesigning their plant for --

MEMBER BROWN: I didn't say that. That's not what I said.

MEMBER STETKAR: We're not reviewing --

CHAIR CORRADINI: And we're not --

MEMBER STETKAR: We're not reviewing the design.

CHAIR CORRADINI: -- we're focusing on the criteria.

MEMBER BROWN: If that's what you want to focus on, fine.

CHAIR CORRADINI: Well, that's the reason that we're here is that the SECY --

MEMBER BROWN: I understand that.

CHAIR CORRADINI: The SECY is basically saying that there's a need for an exemption and we're going to review the exemption request based on these criteria.

MEMBER STETKAR: And eventually we'll review the design --

CHAIR CORRADINI: Right.

MEMBER STETKAR: -- to see whether it

satisfies the basic need to protect the health and safety of the public. Whether it's long-term cooling or reactivity insertion or whatever.

CHAIR CORRADINI: Okay? All right, with that --

MEMBER BALLINGER: Can I say one more thing?

CHAIR CORRADINI: Feel free.

MEMBER BALLINGER: I mean, for this kind of thing I always look for, we sometimes focus on figuring out how it will work. I'd be interested in knowing how it would not work.

In other words, you're into this scenario, you're doing the cooling, it seems to be working, what could happen that would make it not work?

CHAIR CORRADINI: Well I think --

MEMBER BALLINGER: That's nothing to do with GDC 27.

CHAIR CORRADINI: I know, but I think if I would redirect your question, is there something missing from their criteria that would potentially overlook a failure mechanism?

MEMBER RAY: That's right, Mike. Exactly.

CHAIR CORRADINI: Okay, with that we're

adjourned.

(Whereupon, the above-entitled matter went off the record at 4:13 p.m.)

Shutdown Capability of the NuScale Power Module

Derick Botha

Ben Bristol

Allyson Callaway

January 23, 2018

PM-0118-58154
Revision: 0

Acknowledgement & Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0000633.

This report was prepared as an account of work sponsored by an agency of the United States (U.S.) Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

Outline

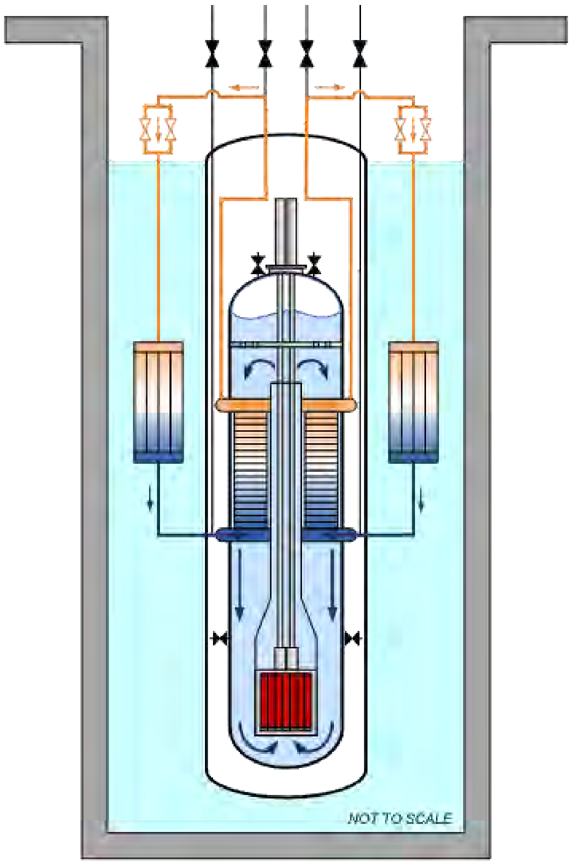
- Background
- Design Overview
- Reliable Means for Shutdown
- Consequence of a Return to Power
- Design Considerations for Shutdown
- Precedent for a Return to Power
- Summary

Background: GDC 27 Exemption

- Reactivity control systems are well-matched to the simplicity and passive safety of the NuScale design.
  - Safety-related control rods
  - Nonsafety-related chemical volume and control system (CVCS)
- Small core with higher control rod worth leads to potential for benign, low probability return to power event with highest worth rod stuck out (WRSO) assumption.
- NuScale's white paper on reactivity control (LO-1116-51829, Nov 2016) addressed compliance with GDC 26 and 27, which address two separate reactivity control functions.
  - Protection function: Rapid power reduction to protect fuel
  - Shutdown function: Capability to hold the core subcritical under cold conditions
- NRC staff position (ML16116A083, Sep 2016): required an exemption from GDC 27 to depart from precedent (i.e., long term shutdown with WRSO).

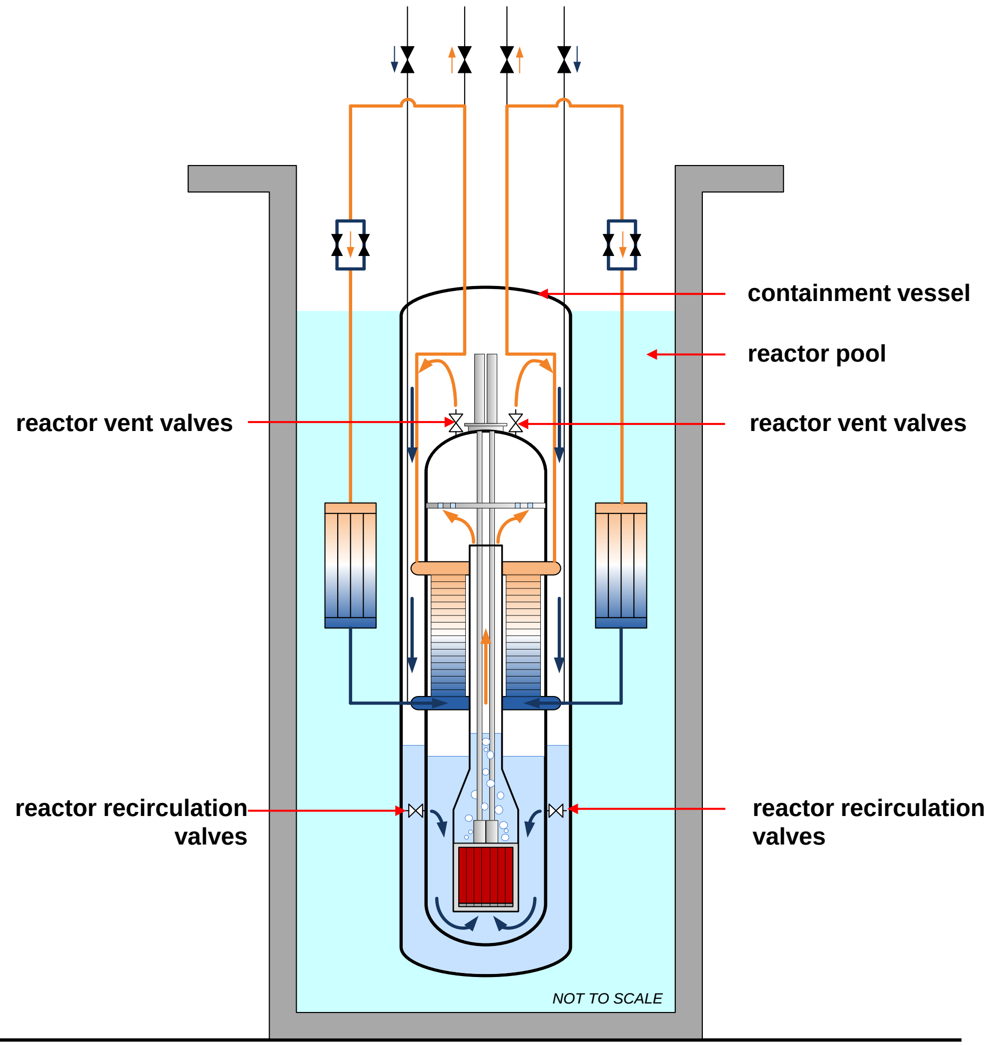
Design Overview: Passive Decay Heat Removal System

- Main steam and main feedwater isolated
- Decay heat removal (DHR) valves opened
- Decay heat passively removed via the steam generators and DHR heat condensers to the reactor pool
- DHR system is composed of two independent and redundant trains (1 of 2 trains needed)



Design Overview: ECCS and Containment Heat Removal

- Adequate core cooling is provided without the need for safety-related injection
- Reactor vent valves and Reactor recirculation valves open on emergency core cooling system (ECCS) actuation signal
- Decay heat removed
  - condensing steam on inside surface of containment vessel
  - convection to the pool fluid on outside vessel wall



Reliable Means for Shutdown

- Protection function: highly reliable safety-related means for achieving rapid reactor shutdown
  - In all cases, reactor immediately shuts down after a trip using control rods, with WRSO
- Shutdown function: under nominal conditions, the reactor remains shut down under cold conditions with reliance only on control rods
  - indefinitely when all control rods are inserted, **or**
  - indefinitely with WRSO during first 70 percent of equilibrium fuel cycle, **or**
  - for 30 days (typical) assuming WRSO while decay heat remains above 100 kW* because of negative reactivity feedback from voiding in the core.
- A return to power is a benign, low probability event that can only occur under a limited set of conditions (e.g., WRSO, loss of power, late in core life, and with low levels of decay heat).

*Depending on core burnup at shutdown, decay heat of 100 kW would be reached at 50 days BOC to 100 days EOC.

Reliable Means for Shutdown

- A return to power is highly unlikely (< 1E-6 per year) and involves
  - the probability of a stuck control rod (2E-4 per demand),
  - the probability of a CVCS failure to insert soluble boron (8E-3 per demand), and
  - the probability that the reactor is in a state that could result in a return to power with a WRSO (4E-2 to 1E-1 per year).

Consequence of a Return to Power

- For licensed designs, a return to power can challenge heat removal system capacity of active safety-related systems, resulting in core damage.
- The capacity of NuScale's passive heat removal systems protects the core, irrespective of control rod performance.
  - Core is protected after a return to power with a WRSO, or even after a failure to trip the reactor (ATWS).
  - Reactor power is limited by negative reactivity feedback while removing heat with DHRS or ECCS.

PM-0118-58154
Revision: 0

Template #: 0000-21727-F01 R1

Consequence of a Return to Power

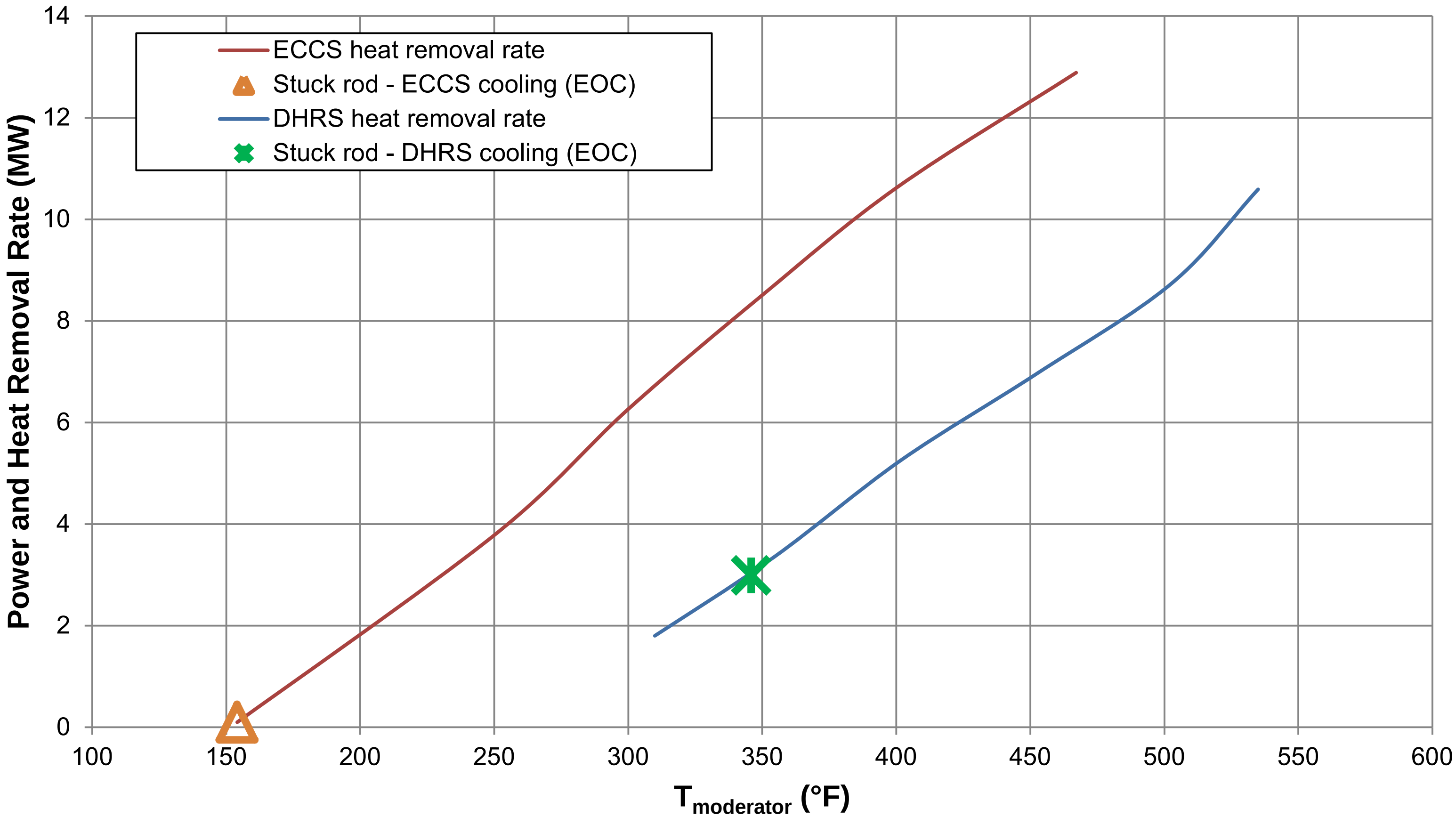
- DHRS heat removal example: Loss of feedwater with WRSO
- DHRS heat removal characteristic in combination with negative moderator coefficient leads to self-limiting condition
  - higher power -> higher moderator temperature -> negative moderator feedback
- DHRS capacity to remove heat is sufficient for power generated with a WRSO
- A return to power with a WRSO while on DHRS is presented in Chapter 15 of the DCA
  - demonstrates that fuel remains protected using conservative deterministic analysis
- Under nominal conditions, a return to power while using DHRS can be avoided

Consequence of a Return to Power

- ECCS heat removal example: RCS depressurization with WRSO
- Depressurization results in shutdown due to voiding, until voiding subsides
- ECCS heat removal characteristic in combination with moderator density decrease due to voiding leads to self-limiting condition
  - higher power -> lower moderator density due to voiding -> negative density feedback
- ECCS capacity to remove heat is sufficient for power generated with a WRSO
- A return to power with a WRSO while on ECCS (<100 kW) is bounded by normal ECCS cooldown with decay heat

Consequence of a Return to Power

- Equilibrium power after return to power with WRSO is within DHRS and ECCS heat removal capacity



PM-0118-58154
Revision: 0

Template #: 0000-21727-F01 R1

Design Considerations for Shutdown

- The NuScale control rod design utilizes conventional external magnetic jack control rod drives because of extensive operating experience and well-documented reliability.
- The safety-related control rods provide sufficient shutdown capability. An additional separate safety-related reactivity control capability is not needed to ensure overall safety.
  - **Passive system reliability:** Low probability of a stuck rod (2E-4 per demand) compared to typical active ECCS unreliability (1E-2 per demand). After successful control rod insertion, no further operator actions are required to protect the core.
  - **Passive system simplicity:** The design relies on passive control rod insertion. The inclusion of additional safety-related capability will increase design complexity, and introduces additional failure modes that could, for example, result in containment bypass (due to external module piping connections that would be required to open).

Design Considerations for Shutdown

- NuScale design aligns with the NRC's advanced reactor policy statement (73 FR 60612; October 14, 2008) for an advanced reactor design
  - "Highly reliable and less complex shutdown and decay heat removal systems. The use of inherent or passive means to accomplish this objective is encouraged (negative temperature coefficient, natural circulation, etc.)."
  - "Simplified safety systems that, where possible, reduce required operator actions, equipment subjected to severe environmental conditions, and components needed for maintaining safe shutdown conditions. Such simplified systems should facilitate operator comprehension, reliable system function, and more straightforward engineering analysis."
  - "Design features that can be proven by citation of existing technology, or that can be satisfactorily established by commitment to a suitable technology development program."

Precedent for a Return to Power

- GSI-22, Inadvertent Boron Dilution Events
  - 2E-4 per reactor year for a return to power
- NUREG-1449, Shutdown and Low-Power Operation
  - 1E-5 per reactor year for core damage due to rapid boron dilution
- GSI-185, Control of Recriticality Following Small-Break LOCAs
  - 3E-8 per reactor year for core damage due to inadvertent boron dilution during a small-break LOCA transient
- 10 CFR 50.62, ATWS
  - Goal to reduce ATWS CDF to less than 1E-5 per reactor year

In contrast, a return to power for NuScale is a low probability, low consequence event.

Summary

- Reactivity control systems appropriately matched with the simplicity and passive safety of the NuScale design provides:
  - rapid shutdown to protect fuel
  - reliable capability to maintain the reactor subcritical under cold conditions
  - passive heat removal provides protection against control rod malfunctions
- Design of reactivity control systems aligns with the NRC's advanced reactor policy statement (73 FR 26349; October 14, 2008) for an advanced reactor design
- A return to power with a WRSO is a benign event with a lower probability than the core damage frequency of approved designs

6650 SW Redwood Lane, Suite 210
Portland, OR 97224
971.371.1592

1100 NE Circle Blvd., Suite 200
Corvallis, OR 97330
541.360.0500

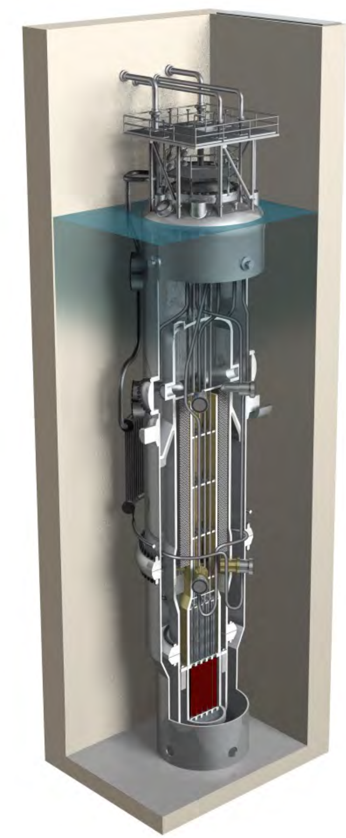
11333 Woodglen Ave., Suite 205
Rockville, MD 20852
301.770.0472

2815 Coliseum Centre Dr., Suite 230
Charlotte, NC 28217
980.349.4804

1933 Jadwin Ave., Suite 130
Richland, WA 99354

1st Floor Portland House
Bressenden Place
London SW1E 5BH
United Kingdom
+44 (0) 2079 321700

http://www.nuscalepower.com



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

NuScale Exemption Request to General Design Criterion 27

By
Jeff Schmidt – Senior Reactor Engineer, NRO/DSRA/SRSB
1/23/2018

Purpose

Brief the ACRS on the acceptance criteria the staff plans on using to evaluate NuScale's exemption to General Design Criterion 27, "Combined Reactivity Control System Capability," as described in the staff's draft Commission paper

Technical Background

- Late in pre-application, the staff learned the NuScale reactor would return to and sustain fission power (become and remain recritical) under Chapter 15 design basis assumptions
- Assumptions include:
  - A stuck rod, which is consistent with current GDCs
  - Loss of AC power
  - Non-safety related Chemical and Volume Control System (CVCS) is unavailable
  - Sufficiently negative MTC (occurs during most of an operating cycle)
- Using design basis assumptions, return to power will occur following most AOOs and postulated accidents for the long term
- Maximum core return to power ~9%, peak pin power > 50%
- Design remains subcritical if all control rods insert

Regulatory Background

- General Design Criterion 27 states,
  - The reactivity control systems shall be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.
- Staff review focused on meaning of “reliably controlling reactivity changes”
- SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs,” stated,
  - “…that conditions other than cold shutdown may constitute a safe shutdown state as long as reactor subcriticality, decay heat removal, and radioactive materials containment are properly maintained for the long term.”

Regulatory Background (cont)

- Definition of safety-related SCCs in 10 CFR 50.2 states,
  - (2) The capability to shut down the reactor and maintain it in a safe shutdown condition
- The NRC has licensed designs which return to power in the short term following some postulated accidents (e.g., PWR Main Steam Line Breaks)
- The NRC has not licensed a power reactor that does not achieve subcriticality in the long term using only safety-related systems
- Staff's responded to NuScale that an exemption to GDC 27 would be required and such an exemption would warrant Commission consideration and direction prior to the staff's approval (ML16116A083)

NuScale's PDC 27 and Exemption Request

- PDC 27 in DCD Section 3.1.3.8 states,
  - "The reactivity control systems shall be designed to have a combined capability of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained

    Following a postulated accident, the control rods shall be capable of holding the reactor core subcritical under cold conditions, without margin for stuck rods provided the specified acceptable fuel design limits for critical heat flux would not be exceeded by the return to power"

NuScale’s PDC 27 and Exemption Request (cont)

- Exemption – no undue risk and public health and safety

  “This exemption will not impact the consequences of any design basis event and will not create new accident precursors. The NuScale plant incorporates reactivity control provisions to assure the capability to cool the core is maintained under postulated accident conditions, and to reliably and safely shutdown the reactor. Therefore, the exemption will not present an undue risk to the public health and safety.”

Staff’s Review Approach

- Staff applied the Enhanced Safety Focused Review Approach (ESFRA) at the beginning of the review
  - Identified this issue would receive more emphasis in terms of review scope and depth, compared to a traditional review, using the ESFRA tool
- Staff is early in the review of the analysis (Phase 1) and continues to apply ESFRA in its review
- Technical audits of NuScale analyses is ongoing, as well as staff confirmatory analyses

Staff's Review and Acceptance Criteria

- Chapter 15 review considers,
  - Conservative analysis assumptions, worst stuck rod and using minimum critical heat flux ratio (MCHFR) as the acceptance criteria to demonstrate adequate cooling and maintain the fission product barrier
  - This is consistent with the methodology typically used to analyze PWR main steam line break, short-term return to power
  - Does not consider the probability of occurrence (event probability is 1)
- Exemption review will consider,
  - Chapter 15 acceptance criteria are met (SAFDLs)
  - Shutdown is maintained assuming all control rods insert
  - Probability of occurrence is low (not within the lifetime of a module)
- If above are met the staff anticipates recommending granting the GDC 27 exemption and approval of a final version of PDC 27