

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: 650th Meeting of Advisory Committee on
Reactor Safeguards

Docket Number: N/A

Location: Rockville, Maryland

Date: February 8, 2018

Work Order No.: NRC-3507

Pages 1-113

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.

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

www.nealrgross.com

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

+ + + + +

650TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

THURSDAY

FEBRUARY 8, 2018

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Advisory Committee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., Michael
Corradini, Chairman, presiding.

COMMITTEE MEMBERS:

MICHAEL L. CORRADINI, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

MARGARET SZE-TAI Y. CHU, Member

VESNA B. DIMITRIJEVIC, Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

1 DANA A. POWERS, Member
2 HAROLD B. RAY, Member
3 JOY L. REMPE, Member
4 PETER RICCARDELLA, Member
5 GORDON R. SKILLMAN, Member
6 JOHN W. STETKAR, Member
7 MATTHEW SUNSERI, Member

8

9 DESIGNATED FEDERAL OFFICIAL:

10 MICHAEL SNODDERLY

11

12 ALSO PRESENT:

13 DERICK BOTHA, NuScale

14 MARK CARUSO, NRO

15 DARRELL GARDNER, NuScale

16 REBECCA KARAS, NRO

17 WILLIAM RECKLEY, NRO

18 JEFFREY SCHMIDT, NRO

19

20

21

22

23

24

25

CONTENTS

NuScale Design Certification Application Request
for Exemption from General Design Criteria 27

<u>ITEM</u>	<u>PAGE</u>
Call to Order	4
Opening Comments	4
Presentation by Mr. Gardner, NuScale	7
Presentation by Mr. Botha, NuScale	24
Presentation by Mr. Schmidt, Reactor Systems Group	67
Public Comment	111
Strategy for Discussion About Topic	111
Recess	113

P R O C E E D I N G S

8:30 a.m.

CHAIR CORRADINI: Okay, the meeting will come to order.

This is the first day of the 650th meeting of the Advisory Committee on Reactor Safeguards.

During today's meeting, the Committee will consider the following, NuScale Design Certification Application Request for Exemption from General Design Criteria 27, biennial review and evaluation of the NRC Safety Research Program and preparation of ACRS reports.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. As such, this meeting is being conducted in accordance with the provisions of FACA.

That means that the Committee can only speak through its published letter reports.

We hold meetings to gather information to support our deliberations. Interested parties who wish to provide comments can contact our offices requesting time after the Federal Register Notice describing the meeting as published.

That said, we also set aside ten minutes for extemporaneous comments from members of the public

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

(202) 234-4433

(202) 234-4433

1 attending or listening to our meetings. Written
2 comments are also welcome.

3 Mike Snodderly is the Designated Federal
4 Official for the initial portion of the meeting.

5 The ACRS section of the U.S. NRC public
6 website provides our charter, bylaws, letter reports
7 and full transcripts of all our full and Subcommittee
8 meetings including all slides presented at those
9 meetings.

10 We received no written comments or
11 requests to make oral statements from members of the
12 public regarding today's session.

13 And, there also will be a phone bridge
14 line. To preclude interruption of the meeting, the
15 phone will be placed in a listen in only mode during
16 the presentations and Committee discussions.

17 A transcript of the portions of the
18 meeting is being kept and it is requested that the
19 speakers use only one of the -- use one of the
20 microphones, identify themselves and speak with
21 sufficient clarity and volume so they can be readily
22 heard.

23 A couple of other notes, I just want to
24 make sure everybody silences their phones or
25 appliances or anything so we don't have any buzzing or

1 ringing during the meeting.

2 And, also make an announcement, I very
3 proudly would like to announce that Dr. Margaret Chu
4 has just been elected to the National Academy of
5 Engineering.

6 (APPLAUSE)

7 CHAIR CORRADINI: And so, we're honored to
8 have her with us today.

9 Okay.

10 (OFF MICROPHONE COMMENTS)

11 CHAIR CORRADINI: That question, I'm not
12 going to answer.

13 Okay, so, our first topic is the NuScale
14 Design Certification Application Request for Exemption
15 from GDC 27.

16 We had a Subcommittee meeting on, I guess,
17 running this portion of the meeting, we had a
18 Subcommittee meeting on --

19 (OFF MICROPHONE COMMENTS)

20 CHAIR CORRADINI: Thank you, I knew it was
21 a Monday or a Tuesday, January 23rd, a couple weeks
22 ago.

23 And, we discussed this with both the
24 license --- the application and the staff. And so, I
25 think we had most people there. I think three or four

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 weren't able to attend.

2 So, to most of the Committee, this will be
3 a bit of a summary of what we heard over four or five
4 hours.

5 So, to start us off, I think, Darrell,
6 will you be the one that starts us off on this topic?

7 So, go ahead.

8 MR. GARDNER: Good morning.

9 Thank you, Mr. Chairman.

10 So, this is, as you mentioned before, a
11 Full Committee presentation of a topic that we
12 presented on on January 23rd.

13 Appreciate the opportunity to come back
14 and speak to the Full Committee.

15 It will be myself and Derick Botha today.
16 We're going to split the presentation up into pieces.
17 So, we'll go ahead and get started.

18 So, just an outline of what we're going to
19 talk about today. First of all, we wanted to get into
20 the GDC 27 exemption. Again, the reason we're here is
21 to support the staff's information SECY that's going
22 up to the Commission related to our request for
23 exemption on GDC 27.

24 We'll spend a little bit of time talking
25 about the design in terms of the reactivity control

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 systems, again, a high level.

2 We'll talk about the exemption review
3 criteria that we've looked at and some design
4 evaluation overviews that we've done today.

5 And then, of course, a summary of the key
6 points at the end.

7 I would like to point out, as we spoke the
8 last time, that the Full Committee hasn't yet had the
9 opportunity nor the Subcommittees to look at the
10 entire design of the NuScale design. So, we're out in
11 front of that normal review process with respect to
12 this exemption.

13 So, many of the things we're going to talk
14 about is going to necessarily be at a high level
15 before we've had the time to get into lots of details
16 on the design. That will be forthcoming as we get
17 into the review of the rest of the application.

18 So, with that said, so, with respect to
19 the GDC 27 exemption, as we mentioned the last time,
20 so there is the possibility, low likelihood, of a
21 return to power condition with very limited
22 assumptions and conditions.

23 That's generally driven by the passive
24 cooldown nature of the NuScale design to low RCS
25 temperatures. We don't have these whole points at hot

1 standby, hot shutdown the plant through a transient
2 with no power is going to cooldown.

3 MEMBER MARCH-LEUBA: By very limited
4 conditions and assumptions you mean low probability or
5 what do you mean by that?

6 MR. GARDNER: Yes, so it's -- so, and
7 Derick's going to get into that in a little bit more
8 detail, but it would be --

9 MEMBER MARCH-LEUBA: I'll wait.

10 MR. GARDNER: Okay.

11 MEMBER MARCH-LEUBA: Thank you.

12 MR. GARDNER: So, again, as I mentioned
13 before, the focus here is really against these
14 criteria of how you would evaluate such an exemption
15 to the GDC.

16 I will say that NuScale looked at this as
17 part of our design review when the condition was
18 identified. And, we did not identify a need to take
19 an exemption from the GDC. Okay?

20 Our understanding of the language is that
21 the design approach would satisfy the GDC as it's
22 currently written.

23 Our legal team went and did some reviews
24 in this area and they determined that similar
25 considerations were made back during the original

1 drafting of the GDCs. In fact, some of the original
2 draft language included language related to
3 subcritical, the industry comments questioned that and
4 the language was changed to the language that you see
5 today.

6 And, which we believe sort of suggests
7 that the Commission considered this and intentionally
8 made a change in the language.

9 Nevertheless, we believe that the design
10 is consistent with both the literal language and
11 intent of those GDCs as finally published.

12 We did submit a white paper on this
13 subject in 2016. And, I think that you've had access
14 to review that paper.

15 Key points in the paper that there are two
16 functions that we believe are principally addressed by
17 these GDCs. And, that's a protective function and a
18 shutdown function with GDC 26 and 27.

19 And, we think those are separate issues
20 and language, and GDC 26 brings out that specific
21 shutdown function.

22 CHAIR CORRADINI: So, can we just -- so,
23 from the standpoint of you and the staff, 26 is
24 satisfied and the reason is? Or, not satisfied, but
25 it does not require an exemption and the reason is,

1 again? Can you just repeat what you just said that I
2 understand it properly?

3 MR. GARDNER: Well, I'll probably let the
4 staff speak to that when they come up.

5 CHAIR CORRADINI: Okay, fine, fine.

6 MR. GARDNER: That has not been an issue
7 so far, it's just been the language of 27.

8 CHAIR CORRADINI: All right, thank you.

9 MR. GARDNER: Okay, so, again, during the
10 staff review of a document that we submitted during
11 pre-application called the gap analysis, the staff
12 reviewed that and took a position that an exemption
13 from GDC 27 was necessary. And, they cited their
14 reasons for that need.

15 So, again, as part of the application
16 development, we prepared an exemption from the GDC.

17 I would like to point out that whether or
18 not exemption is required, I know there was some
19 discussion about that at the last meeting, that we
20 believe the design solution and the safety
21 demonstration are not changed by whether or not an
22 exemption is necessary. It's the same outcome.

23 Also, there was some discussion about, you
24 know, the need for a PDC versus a GDC. And, we simply
25 wanted to point out that the language in 10 CFR 50

1 Appendix A does direct the applicants to define
2 principle design criteria for the design and with
3 respect to design basis.

4 So, I know there was some discussion about
5 that in the past. And, hence, we have proposed a PDC
6 that's provided here on the slide. The principle
7 difference being one is that our system doesn't have
8 poison edition through the ECCS system language which
9 we removed. And, the addition of the second paragraph
10 that's specific to how we intend to satisfy the design
11 basis with respect to maintaining the reactor
12 subcritical.

13 MEMBER KIRCHNER: Just a question,
14 Darrell.

15 Are you also planning on submitting
16 something that's different than the current GDC 34
17 which was ECCS system performance?

18 MR. GARDNER: So, what I remember is we've
19 taken exemption from a number of GDCs. I'll have to
20 look that up but I think 33, 34.

21 MEMBER KIRCHNER: Have you --

22 MR. GARDNER: I think it's more related to
23 testing.

24 MEMBER KIRCHNER: Have you also filed for
25 an exemption from 34 or you are proposing a PDC that's

1 different?

2 I understand your design is different, I
3 get that.

4 MR. GARDNER: Could I look that up on the
5 break and get back to you?

6 MEMBER KIRCHNER: Thank you.

7 CHAIR CORRADINI: If I may, just to
8 reflect on what we said in the Subcommittee, so our
9 focus today is 27, we might want to clarify other
10 things. And, in particular, the SECY which identifies
11 the criteria staff is going to consider in evaluating
12 the exception request.

13 MR. GARDNER: That's correct.

14 MEMBER KIRCHNER: But, I would just
15 observe, Mr. Chairman, that piecemeal -- the GDCs, the
16 intent at least, is a system of principles that
17 provide defense in depth and some assurance of
18 protecting the safety and health of the public.

19 And, a number of these GDCs interrelate
20 with each other. For example, 34 presumes that you
21 are shutdown. You only have decay heat to remove.

22 So, it's a system, it's not just piecemeal
23 legislation of things that you pick and choose as you
24 would like.

25 MEMBER SKILLMAN: Darrell, the second

1 bullet in your PDC surgically identifies the control
2 rods. And so, as that bullet is written, it would be
3 difficult for anyone to argue with you in that
4 standing. The control rods will keep the thing
5 subcritical.

6 The real issue is, at least in my
7 perspective, after an AOO, the control rods and the
8 other system ensure that k-effective is less than one
9 and it stays there.

10 In the interpretation that you're using,
11 you've basically said, let me back up, you've
12 communicated that shutdown on a hold down are not
13 required. It's simply not exceeding the SAFDLs, the
14 fuel limits.

15 And so, in this PDC, in your PDC 27,
16 you've really avoided fully addressing shutdown and
17 hold down except to the extent that your control rods
18 will give shutdown.

19 And, I don't think any of us can argue
20 with that.

21 But, the larger principle is absent and I
22 think at least that's what's driving my angst here.

23 MR. GARDNER: Sure, I think I would say
24 that it's a combination of how we satisfy GDC 26 and
25 27.

1 MEMBER SKILLMAN: I agree with that.

2 MR. GARDNER: So, Derick had some comments
3 on that.

4 MR. BOTHA: Yes, and I think --

5 CHAIR CORRADINI: You need to go green.

6 MR. BOTHA: And, I think what I, too, just
7 to add on GDC 26 and the language, we're not focusing
8 too much on that today because the exemption is on GDC
9 27.

10 But, we did quite a bit of review of the
11 history behind the GDCs and that's described in the
12 white paper and the way that the draft GDCs changed to
13 the final GDCs and how they're changed is not
14 thoroughly documented, but you can go and look at the
15 original language. I've done that. And, the original
16 language used the word shutdown for all the function.

17 And, the comments from industry was
18 specifically from Oak Ridge, and that's mentioned in
19 the white paper, that when you look at the functions
20 with regard to activity control, you need to
21 distinguish between dynamic reactivity control, so
22 that's to certain negative reactivity.

23 It does not necessarily relate to shutdown
24 but it relates the function of predicting the fuel.
25 You need to distinguish between that and the margin

1 that you need to establish for that and you need to
2 separately look at the capability to maintain the core
3 subcritical.

4 So, previously, if you look at the
5 shutdown function under cold condition, it just had in
6 the draft GDC's language to say, well, you just have
7 to have some margin. They took that out and just
8 said, well, you just have to be subcritical and
9 there's no mention of having margin with a stuck rod
10 and the GDC 26 language.

11 And, that's -- so, based on the comment
12 and the changes, the intent there was, well, when you
13 look at the important function which is to protect the
14 safety of the fuel, there you have to -- and,
15 specifically, the rapid shutdown function.

16 There a shutdown -- assuming a stuck rod
17 is important because if one rod comes in slowly before
18 it's on board, you may not get any reactivity as fast
19 as you need to to protect your fuel.

20 So, that's -- that was the reason, at
21 least the way we interpret it, to look at those
22 distinctions.

23 So, we would say that that distinction is
24 intentional and that our designs -- if you look at our
25 designs with all rods inserted, we can maintain the

1 core subcritical under all conditions.

2 So, we would say we meet both of the
3 exempt and the literal language of that GDC 26.

4 And, I don't know if that answers your
5 question.

6 MEMBER SKILLMAN: Well, it certain is an
7 explanation that I understand. But, the conclusion
8 that you end up at is where I depart from agreement.
9 And, I hold very tightly onto your evaluation, it's on
10 page 14 of your white paper.

11 And, these are the words that caused me
12 the greatest angst.

13 Regulation of low probability events with
14 no safety consequences such as the unlikely potential
15 for a benign return to power would be inconsistent
16 with past resolution and issues.

17 And, I would say, I don't agree with that
18 at all. I believe through our history, there has
19 always been the idea you might have a return to power
20 for a transient, I concur with that.

21 But, not for the long-term and certainly
22 not a return to power that's neither monitored nor
23 controlled. And, the idea of a benign return to power
24 is kind of like, in my mind, a benign root canal.

25 It has substantial importance. And, when

1 we see the NSSS vendor say, we can have a criticality.
2 It's really not so bad because the fuel cell heat, I
3 must tell you, I am alarmed.

4 And, in this Committee, I'm speaking for
5 myself, that, to me, provides conflicts on your second
6 bullet because it says to me, okay, NuScale is saying
7 we can drive with subcritical with rods, that's dandy.
8 I would like to be assured that with the rods and
9 whatever else you have, you not only ensure its
10 subcritical, but it's stays there.

11 And, I don't see that coming out. You're
12 claiming it's in 26, I'm saying 27 is related to it.
13 And, when you make the case that you're protecting the
14 fuel, I would say, you're counting on decay heat to
15 produce voiding to ensure shutdown.

16 So, you're going for fuel limits, not hold
17 down. I think 27 really intends that this machine be
18 shutdown, not just protect the fuel.

19 And, I believe that that is there from the
20 six or seven criterion from the original 1967
21 criterion. I believe they were carried over into the
22 70 general design criteria, which are the ones that we
23 see today.

24 So, I'm -- I guess I'm calling out on that
25 second bullet because, by surgically identifying rods,

1 I would say, yes, I'm sure, if all your rods are
2 working, you'll go subcritical. If they're not, maybe
3 not. And, you don't, in my view, have a back up that
4 is proof certain driving subcritical. Okay?

5 MR. GARDNER: We can appreciate the
6 comment.

7 I would just say, I think you're raising
8 the matter of policy which is the basis behind why the
9 staff is proposing the information SECY to the
10 Commission to get that policy question addressed.

11 MEMBER SKILLMAN: I've stated my case.

12 MR. BOTHA: And, I think there may be --
13 when we go to the design evaluation, there may be some
14 of the information there that can provide additional
15 context to explain why the design as is is more than
16 the additional certainty than you -- that you would
17 require for that function. But, I think that's going
18 to come later in the presentation.

19 MEMBER SKILLMAN: Okay. And, just looking
20 ahead --

21 MR. BOTHA: But, I appreciate --

22 MEMBER SKILLMAN: Looking ahead, you may
23 be right. But, I will tell you, for a core that's
24 depending on natural circulation with a rod stuck out
25 and potentially with uncertainty about geometry, the

1 flow rates that are necessary to homogenize and get
2 the boron concentrations you need, and the numbers I'm
3 stuck on, are about a 100 ppm of percent delta-k/k.

4 For a 2 or 3 percent rod, you need an
5 increase in 200 to 300 ppm boron to achieve the
6 shutdown.

7 And, I've lived that life at TMI 2, we
8 didn't know what we had. We were depending on natural
9 circulation. Thank heaven we had a reactor cooling
10 pump to make sure that we had homogenized boric acid
11 concentration.

12 You have no such mixing capability. So,
13 I've thought this through pretty clearly and I think
14 there are some weaknesses and they're certainly not
15 identified in your current Chapter 15 analysis. Those
16 are the only analysis that were provided to us.

17 MR. GARDNER: So I understand the
18 question, I would say that -- so, some of the details
19 that you're talking about would be things that we
20 would get in as we get into those detail system design
21 description and analyses that are going to come during
22 the chapter review.

23 MEMBER SKILLMAN: Then --

24 MR. GARDNER: We're not really prepared to
25 get into that level of detail --

1 MEMBER SKILLMAN: Then, are we --

2 MR. GARDNER: -- here.

3 MEMBER SKILLMAN: -- premature in trying
4 to work our way through this?

5 MR. GARDNER: Well, I think the question
6 we're looking at today is whether these are the
7 appropriate criteria to consider. And then, how those
8 criteria satisfy will be answered during subsequent
9 reviews and when we bring the chapters that
10 demonstrate how we've addressed those criteria.

11 MEMBER REMPE: So, I wasn't --

12 MEMBER SKILLMAN: Thank you.

13 MEMBER REMPE: -- at the Subcommittee
14 meeting, but I did read the transcript, which doesn't
15 make me an expert.

16 And, one thing that puzzled me, because
17 really, this is something that is -- when you get into
18 the SECY and what the Commission is going to decide
19 on, it's not just your reactor design and all the
20 details, it's a policy change, as you mentioned.

21 And, the staff has two criteria they're
22 asking to have met is how they're going to evaluate
23 your exemption.

24 And, your slides today don't discuss those
25 criteria at all. And, I will be discussing with the

1 staff, too, and asking them.

2 But, because how the staff looks at those
3 criteria, I'm puzzled if how much margin they're going
4 to want. I mean, basically, they're going to rely
5 more on your ability to assess the frequency of such
6 events. Right?

7 And, how much data that they want to have
8 certainty that you're not -- with respect to the long-
9 term cooling being satisfied.

10 And, have you discussed with the staff, do
11 you understand what you're going to have to meet if
12 you have to go through with this exemption? And, are
13 you comfortable with it?

14 I mean, have they conveyed to you how much
15 uncertainty you're going to have to meet these
16 criteria with? I mean, I was looking at this, I was
17 going, oh, be careful what you ask for here because
18 you may decide it may be difficult to meet those
19 criteria.

20 And, those criteria may, you know, they're
21 going to have to apply them if somebody else comes in
22 with a design, Joe's reactor, and I'm just -- I was
23 puzzled that no one discussed that during the
24 Subcommittee meeting.

25 MR. GARDNER: Sure.

1 A couple thoughts. What is the exemption
2 request is specific to NuScale and the PDC would be
3 specific to NuScale. So, it's not a change to the
4 rule for GDC 27, it's --

5 MEMBER REMPE: But, somebody else can
6 follow along.

7 MR. GARDNER: They would have to pursue a
8 similar process for exemption request and/or rule
9 making so it's not --

10 MEMBER REMPE: And, how much uncertainty
11 the staff allows with your concept and how much
12 margin, how much data they require, all of those
13 things will set precedent for future reactors.

14 And, I just was curious, have you
15 discussed with them? Do you understand what you're
16 going to have to meet if they come in there and you
17 feel comfortable that those margins are going to be
18 appropriate and not a burden?

19 MR. GARDNER: Certainly it's under review
20 now. I don't think the staff has progressed far
21 enough to reach a conclusion. I'll let them speak to
22 it when they come up.

23 But, it is under review and we're having
24 those kind of dialogues as we speak.

25 MEMBER REMPE: And, it doesn't cause you

1 any heartburn, huh? Not at all? Okay.

2 MR. GARDNER: Not today.

3 MEMBER REMPE: Okay.

4 CHAIR CORRADINI: I think Joy is asking in
5 a polite way, I hope you understand what you're
6 getting into.

7 MEMBER REMPE: Be careful what you ask
8 for.

9 MR. GARDNER: I think we heard that
10 admonishment at the Subcommittee meeting.

11 CHAIR CORRADINI: Okay, fine. Okay, good.
12 Proceed.

13 MR. GARDNER: Okay, that's all I had, so
14 I'm going to turn it over to Derick to get into some
15 -- a little bit of overview of the design.

16 MR. BOTHA: Yes, just, before I get into
17 that, a little bit of my background for Full
18 Committee.

19 Prior to NuScale, I worked at PBMR in
20 South Africa. I spent about 10 years there and I've
21 got about 7 years under my belt at NuScale. I'm the
22 Innovation Manager at NuScale.

23 But, I've also got quite a bit of
24 experience -- technical experience -- in thermal
25 systems modeling and safety analysis as well as on

1 licensing. So, I helped with putting the design
2 certification together and also worked on -- did some
3 extensive work on this topic.

4 Just before I get started on this slide,
5 how much time do we have left for this session?

6 CHAIR CORRADINI: We have about 30
7 minutes.

8 We will allow you another 30 minutes.

9 MR. BOTHA: Okay.

10 CHAIR CORRADINI: For the NuScale
11 presentation.

12 MR. BOTHA: Thank you.

13 CHAIR CORRADINI: No problem.

14 MR. BOTHA: So, just very briefly, an
15 overview of the reactivity control systems and also
16 specifically with this issue.

17 So, we have two reactivity control systems
18 that's most relevant to this topic. There is -- we
19 have -- also, before I get into these two, we also
20 have containment flood and drain system through which
21 you can also add boron and water is also is a non-
22 safety related system, but these are the two we use
23 most of the time during all operations.

24 MEMBER STETKAR: Derick, we haven't
25 received all of the detailed information about the

1 design.

2 You've mentioned in the paper, and you
3 just mentioned it also, the cavity flooding and drain
4 system.

5 Is that connected to what you call the
6 CVCS in your plant? In other words, is it --

7 MR. BOTHA: No, no, it's a completely --

8 MEMBER STETKAR: It's a completely
9 separate --

10 MR. BOTHA: Completely separate system.

11 MEMBER STETKAR: Thank you, that's all.
12 Thanks.

13 CHAIR CORRADINI: It was an internal
14 discussion point. Thank you.

15 MR. BOTHA: Okay.

16 And, there's some redundancy in the CVCS
17 system as well.

18 MEMBER STETKAR: I just wanted to -- thank
19 you.

20 MR. BOTHA: Okay.

21 So, the safety related system we have is
22 our control rods. And, that enables us -- we
23 certainly use it during normal operation for boron
24 control, but that enables us to rapidly shutdown the
25 reactor. That's our safety related system.

1 But, also, enables us to keep the reactor
2 shutdown with all rods inserted under all conditions.

3 And then, we have our CVCS system that's
4 on one safety related system during normal power
5 operation that enables us to control our reactivity
6 balance and make sure we have enough shutdown margin
7 so you don't have your rods inserted too deeply.

8 And then, also, if you shutdown, it
9 provides you the capability to provide additional
10 shutdown margin. And, obviously, we'll get into the
11 stuck rod discussion.

12 So, those are the two systems we have.

13 Now, if you look at the --

14 MEMBER KIRCHNER: Derick, may I interrupt
15 now at this minute?

16 So, during our Subcommittee meeting, when
17 you talked about your design and your approach, you
18 inferred, I believe, and the transcript will reflect
19 how you answered my question, that you didn't want to
20 have extra penetrations of containment or the reactor
21 vessel.

22 But, clearly, the CVCS system does
23 penetrate both vessels. Certainly, that part of the
24 system inside the reactor, I would assume, is safety
25 grade, quote, unquote. But, we haven't seen the

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 details.

2 So, you are calling this a non-safety
3 grade system, the CVCS?

4 MR. BOTHA: That's correct.

5 MEMBER KIRCHNER: And, the reason is, you
6 do not want to have -- this is a system that needs
7 power?

8 MR. BOTHA: That's correct.

9 MEMBER KIRCHNER: And, therefore, you
10 would need Class 1-E power to run the system?

11 MR. BOTHA: That's correct.

12 If you wanted to rely on it from a safety
13 perspective.

14 So, I -- go ahead, I think you had --

15 MEMBER KIRCHNER: Well, at least from my
16 vantage point, and it shows that the GDCs are open to
17 wide interpretation.

18 The idea of having two independent and
19 diverse systems, I've always felt were presumed,
20 perhaps, incorrectly that these, to the extent that
21 they were relied on to achieve the objectives of the
22 GDCs would be safety class systems.

23 MR. BOTHA: No, not for the existing
24 fleet.

25 And, but, I think there's two questions

1 you had there. One was regarding the penetrations,
2 the other one --

3 MEMBER KIRCHNER: Yes.

4 MR. BOTHA: -- was regarding the GDCs.

5 And, I think maybe the staff can answer
6 your question on the GDCs with regard to other
7 designs.

8 MEMBER KIRCHNER: Yes.

9 MR. BOTHA: But --

10 MEMBER KIRCHNER: Maybe put that aside,
11 but I -- you do have a system that does -- you went
12 through your design options and thinking, and I
13 thought I remember you saying distinctly we decided we
14 didn't want further penetrations of the --

15 But, indeed, the CVCS system has to do
16 that to get the boron injection where you need it.

17 MR. BOTHA: So, I'd like to respond to
18 that and I'll give you a short answer now and then I
19 want to give the rest of the answer as part of the
20 next bullet or the point here on the slide.

21 So, the first point, before I get to the
22 next point that you just have to keep in mind while I
23 provide this answer is the way our safety systems work
24 in our ECCS worked is either when you get into a
25 situation where you don't have power or if you respond

1 to IO events and it's -- if independent, what your
2 safety system or your protection system would do is
3 isolate containment.

4 MEMBER KIRCHNER: Right.

5 MR. BOTHA: So, those isolation valves
6 would actuate so you don't have to rely on those
7 external piping and, obviously, the power that powers
8 the system.

9 But, I'll provide the rest of the answer
10 in terms of that should give you some context of what
11 we meant with additional penetrations.

12 So --

13 MEMBER KIRCHNER: So, with these -- maybe
14 this is perhaps, I guess we have a Subcommittee
15 meeting with NuScale to look at -- coming up.

16 CHAIR CORRADINI: On the 20-something.

17 MEMBER KIRCHNER: Yes, this might inform
18 the discussion.

19 Let me hold off on that.

20 MR. BOTHA: Of course.

21 MEMBER KIRCHNER: Okay, keep going, sorry.

22 MR. BOTHA: So, for the -- so, if we look
23 at our design holistically and our design approach, is
24 we wanted to design a system that is passively safe,
25 doesn't depend on power. So, it relies on passive

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 systems for critical -- to perform the safety
2 functions. That's our overall design philosophy.

3 And, you've sort of seen a little bit of
4 that when we looked at the topical report that we
5 provided on not having any 1-E power systems for our
6 design. So, I think that's been presented to you, to
7 the ACRS.

8 So, with that in mind, if we want to
9 maintain that design philosophy and we want to provide
10 addition reactivity control means, the way you would
11 do that is with a passive boron injection tank.

12 And, the sensible way to do that is that
13 tank has to sit outside of containment and you'd have
14 to have a dedicated safety related line that
15 penetrates both of the vessels.

16 So, that was really to provide you context
17 for the previous comment we made for additional
18 penetrations.

19 And, the comment we made along with that
20 is, that's additional systems. It's additional
21 complexity to the design. And, introduces additional
22 failure modes.

23 But, I think the more important point with
24 regard to adding such a system is, you're not
25 measuring -- you're not measurably increasing the

1 safety of the design. In fact, you could argue you're
2 decreasing it because of the additional failure modes.

3 But, I'll get back to that under the
4 design evaluation.

5 I think with regards to our reactivity
6 control systems, so, in terms of what we rely on in
7 terms of safety is primarily the control rods.

8 Now, that's different from the existing
9 fleet in several respects, but the one is, for the
10 existing fleet, they rely on adding additional water
11 for a number of events, so specifically, your LOCA
12 type events, and that's part their ECCS function.

13 And, as part of that injection capability,
14 they're adding boron.

15 So, we don't have safety injection as one
16 of the functions of our ECCS system. All right? So,
17 that's not how we designed the plant. So, that's a
18 significant difference.

19 I think the other difference that Darrell
20 also alluded to is, when we use our passive heat
21 removal systems, the system naturally cools down for
22 a large reactor, if you look at non-LOCA type events
23 for PWR, you can control the cooldown and stay at this
24 hot shutdown condition.

25 But, I think more importantly, for them to

1 get to a cold subcritical condition consistent with
2 GDC 26, you need two systems for a traditional PWR.
3 You need your rods for your rapid shutdown function to
4 protect your fuel.

5 And then, once you've got your rods
6 inserted, you also have to add boron to get to that
7 condition.

8 So, you need both systems to get there.

9 For the NuScale design, you can get there
10 with either system. So, we provide redundancy over
11 and above what the PWRs provide.

12 So, that's not saying that there unsafe at
13 all, that's just saying we've added additional
14 capability because of the way we've increased our --
15 the capability of our -- because of the fact that
16 we've increased the capability of our rods.

17 So, that's an important distinction.

18 So, for us, the control rods alone can
19 maintain shutdown for the complete RCS temperature
20 range.

21 So, with regards to --

22 MEMBER SKILLMAN: I'd sure like to
23 challenge that. I operated a number of fuel cycles
24 and we started at 1800 ppm, pulled rods, went critical
25 around 1500.

1 MR. BOTHA: Yes.

2 MEMBER SKILLMAN: And, out 695 days, we
3 were at 10 ppm boron. We almost to zero.

4 MR. BOTHA: Yes.

5 MEMBER SKILLMAN: When we shutdown, we
6 shutdown with control rods.

7 MR. BOTHA: That's correct.

8 MEMBER SKILLMAN: And, it stayed shutdown.

9 MR. BOTHA: At hot conditions?

10 MEMBER SKILLMAN: No, well --

11 MR. BOTHA: At hot conditions?

12 CHAIR CORRADINI: That's his point. It
13 didn't go cold.

14 If you went cold, it wouldn't, that's his
15 point.

16 MEMBER SKILLMAN: I got it.

17 MR. BOTHA: So, with --

18 MEMBER SKILLMAN: No, wait, with all rods
19 in, I can be cold in subcritical.

20 MR. BOTHA: Not with the PWR. With a BWR,
21 but not a PWR.

22 MEMBER SKILLMAN: Tell me about it, how
23 you refuel a P? All rods in, cold.

24 CHAIR CORRADINI: You inject boron later.
25 You have to re-boron.

1 MEMBER SKILLMAN: Okay, all right. Okay,
2 not just --

3 MEMBER STETKAR: Depending on how you get
4 it in and what you get it in with, but you put boron
5 in.

6 MR. BOTHA: And, I think --

7 MEMBER SKILLMAN: Clear in my mind.

8 MR. BOTHA: And, to add to that, so --

9 CHAIR CORRADINI: And, there's a failure
10 mode associated.

11 MR. BOTHA: -- there's a whole, I don't
12 want to get off track here too much -- there's a whole
13 -- there's several safety issues that were discovered
14 with the PWRs under best heat removal.

15 So, with the cooling down with natural
16 circulation, and the means they get there with
17 subcritical is with a non-safety related CVCS.

18 That is the stock standard way you get to
19 a cold shutdown condition with a PWR, is with a non-
20 safety related CVCS.

21 And, that's not submitted as part of their
22 FSAR, it's additional documentation that's on there as
23 part of their licensing basis. So, that's not even
24 evaluated as part of the safety evaluation for their
25 licenses.

1 And, that additional documentation was
2 because of these additional issues that was identified
3 by the NRC.

4 MEMBER SKILLMAN: Okay.

5 MR. BOTHA: So, a little bit more just to
6 provide context with regards to the stuck rod
7 condition.

8 So, because we've got a small core and the
9 number of control rods we have, each of those rods, so
10 you're going to have the same number of rods as a
11 large PWR, each one of those rods is worth a lot more.

12 So, if you have one of them stuck out,
13 that's a lot of additional negative reactivity that's
14 not there.

15 So, because of that, there's a limited
16 state of condition that you could see where you could
17 have a return to power.

18 And, we've analyzed that in terms of the
19 number to understand the conditions under which this
20 could occur, we've used our best estimate methods to
21 determine when this could exactly occur. And, we're
22 going to talk a little bit later in the presentation
23 about best estimate versus conservatism as to
24 deterministic. So, I want to defer that.

25 But, to characterize when this could

1 occur, as I mentioned before, immediately, even with
2 a stuck rod, you will go -- you will immediately
3 shutdown the reactor. It's only when you start
4 cooling down.

5 So, we'll firstly, to sort of characterize
6 it, stay shutdown if you have all rods inserted. If
7 you do have a stuck rod, it only happens in the large
8 -- latter portion of your refueling cycle.

9 And, the reason is, for the first 70
10 percent, your boron concentration is high enough that,
11 as you cool down, you're actually concentrating boron
12 because of the increase in your moderate gains. So,
13 then you would stay shutdown for the first fuel cycle.

14 Then, if you do get into this condition
15 but you've shutdown. You've got a stuck rod and it's
16 late in cycle, it can only happen if you don't have
17 your CVCS system available.

18 So, that means either you don't have to
19 have power, and we mentioned flood and drain systems
20 that you could also use, so that also doesn't have to
21 be available.

22 Now, if you're in that condition, you
23 don't have power, CVCS isn't available and it remains
24 available for a very long time, which is very
25 improbable, then what would happen is typically late

1 in cycle, you would have decay heat and that'll
2 generate enough boiling so that you'll stay shutdown
3 for a very long time.

4 So, we're talking for more than 30 days.

5 Now, really, what is not unique, if you
6 look at a large break LOCA, PWRs don't create a rod
7 insertion for a large break LOCA. They rely on boron
8 injections as part of the ECCS.

9 And so, for the first portion of that
10 transient, the means that they're allowing for
11 shutdown is boiling. So, it's not a -- and it's
12 physical, so it's actually it's not a -- it's a well
13 understood condition if you produce heat and water
14 boils.

15 And, that reduces the density of your
16 moderator.

17 MEMBER REMPE: So, your reactor is
18 smaller, but do you have any data needs that you have
19 identified to support some of this high level
20 qualitative response that you're giving us today?

21 I mean, have you gone through and said,
22 oh, yes, to support some of these things, we know
23 we'll need to get X, Y and Z data?

24 MR. BOTHA: So --

25 MEMBER REMPE: Not typical of the --

1 MR. BOTHA: So, you're talking about --

2 MEMBER REMPE: -- differences?

3 MR. BOTHA: So, that's really in the
4 neutronic analysis. And, I'm not -- that's not really
5 my area, so I can't answer that. All I can tell you
6 is that the physics that underpins that and so the
7 reactor physics and the codes and the methods they use
8 is all closely related to the PWRs that's operating.

9 And, in the areas that where we are
10 different, that's well quantified and that's evaluated
11 as part of the review of the application.

12 But, in terms of the specifics of how they
13 model it, especially on the neutronics side, but on
14 the thermal hydraulic side, I mean, it's just --

15 MEMBER REMPE: The passive response,
16 everything you feel like you've got data to support --

17 MR. BOTHA: That's right.

18 MEMBER REMPE: -- your validation?
19 There's nothing unique about -- because we haven't
20 looked at the design details themselves --

21 MR. BOTHA: Yes, so --

22 MEMBER REMPE: -- but I just was curious
23 if you --

24 MR. BOTHA: So, we have --

25 MEMBER REMPE: -- identified a couple of

1 things, oh, we've got to get data to support that or
2 something?

3 MR. BOTHA: Yes, and we have on this
4 program, we have it on this facility. You'll get into
5 all of that with --

6 CHAIR CORRADINI: If I might just
7 interject.

8 MR. BOTHA: Yes.

9 CHAIR CORRADINI: So, for the Committee,
10 we have a two-day session scheduled in the
11 Subcommittee, a week in March, to understand the
12 system completely.

13 And, on May the 15th, we have a
14 Subcommittee meeting on codes and critical heat flux
15 for the design.

16 MEMBER REMPE: I understand that and I
17 understand that this is really the policy decision,
18 but I'm just curious, with the policy decision, are
19 there going to be some data needs?

20 And then, again, how much uncertainty do
21 you have to have with some of the data needs and --

22 CHAIR CORRADINI: But those are -- that's
23 -- I think those are the logical places to bring it
24 up. The main one is --

25 MEMBER REMPE: Yes, well, with the staff

1 --

2 CHAIR CORRADINI: -- talking --

3 MEMBER REMPE: -- though, is where I'm
4 curious on it.

5 CHAIR CORRADINI: Okay.

6 MEMBER KIRCHNER: Derick, may I quickly
7 ask, what's the typical boron concentration at
8 beginning of life and then at end of cycle? You do
9 rely on boron, right?

10 MR. BOTHA: Yes.

11 MEMBER KIRCHNER: Throughout the whole --

12 MR. BOTHA: Yes, and --

13 MEMBER KIRCHNER: Your earlier comments
14 might have inferred that you don't rely on boron for
15 --

16 MR. BOTHA: No, no, so --

17 MEMBER KIRCHNER: -- for shutdown control.

18 MR. BOTHA: So, I can answer the second
19 part of your questions, not the first part.

20 MEMBER KIRCHNER: Okay.

21 MR. BOTHA: So, what we mean with we don't
22 rely on the CVCS inserting boron, if you have an event
23 --

24 MEMBER KIRCHNER: During the event?

25 MR. BOTHA: -- you --

1 MEMBER KIRCHNER: Yes, I got that part.

2 MR. BOTHA: So, you do -- so during normal
3 operations, certainly, you rely on boron and change
4 the boron concentration.

5 MEMBER KIRCHNER: Okay, thank you.

6 MR. BOTHA: So, that gives you a high
7 level overview of our reactivity control systems and
8 this condition where we could realistically expect to
9 see a return to power.

10 So, that, I think, brings us to the next
11 part of our presentation is the criteria.

12 So, how do I know it's safe? So,
13 specifically, with regards to the exemption and the
14 review criteria that the staff's going to get more
15 into this, but, what I have here is the GDC 27
16 perspective.

17 So, for GDC 27, that's really covers
18 postulated accidents and the key criteria that we
19 would look at from a GDC 27 perspective is are you
20 able to cool the core? Right?

21 So, it's core cooling, that's what's
22 required by the GDC 27.

23 And, the review criteria in Chapter 15 for
24 that is whether you stay below your peak cladding
25 temperature, okay, so that your geometry of your fuel

1 needs to be such that you allow for cooling or coolant
2 to flow through the core.

3 You don't want to damage your fuel to the
4 extent that it prevents core cooling. That's really
5 the address behind core cooling with regards to GDC
6 27.

7 So, if you look at the review criteria
8 that the staff are proposing, and they're proposing
9 maintaining CHF limits. So, maintaining CHF limits is
10 more limiting than peak clad temperature because
11 you're maintaining CHF limits, the core has to remain
12 covered.

13 But, not only that, the heat load needs to
14 be low enough that you wouldn't exceed your CHF limit.
15 So, you wouldn't even come close to challenging your
16 core geometry in terms of core cooling.

17 MEMBER POWERS: Let me ask you a question.

18 MR. BOTHA: And this -- go ahead.

19 MEMBER POWERS: You're talking about a
20 situation, something's gone wrong and you're saying,
21 okay, this is wonderful and whatnot. You have not
22 raised the issue of risk, the conditional risk, when
23 I'm in this situation at all.

24 If something has gone wrong, it seems to
25 me plausible that something else goes wrong.

1 And so, what is the conditional risk
2 associated with this particular state?

3 MR. BOTHA: When you're in this condition,
4 when you have a return to power.

5 I cannot give you the detailed answer, I
6 can only give you the high level answer in terms of
7 when we go and look at those type of conditions, we do
8 that as part of our PRA and that certainly feeds into
9 our safety analysis to identify what could go wrong
10 under different conditions.

11 But, from a PRA perspective and looking at
12 all the failure modes, we certainly identify all the
13 plausible paths that leads to core damage.

14 And, under this condition, I think the one
15 detailed answer I can give you, when you're down to a
16 100 kilowatts of heat, you don't even need ECCS flow
17 to keep -- to provide heat removal because your heat
18 production is so low that you can remove heat through
19 conduction through your two vessels.

20 So, each --

21 MEMBER POWERS: That one I never believe
22 because they never take into account the contact
23 resistance when they do those analyses.

24 MR. BOTHA: For the contact resistance for
25 --

1 MEMBER POWERS: When you go try to
2 transfer heat through any boron removal, there's
3 always contact resistance.

4 MR. BOTHA: On these two --

5 MEMBER POWERS: That somehow never gets
6 taken into account.

7 MR. BOTHA: But, on these two --

8 MEMBER POWERS: And, it's only getting
9 worse, by the way.

10 MR. BOTHA: There's the internal and the
11 external heat transfer coefficients. And, you can
12 certainly get into that as we get into the details of
13 the review.

14 CHAIR CORRADINI: But, I think, if I just
15 nail down, you don't have the answer to his question
16 in terms of residual delta risk, that's what I think
17 he's asking.

18 MEMBER POWERS: Yes.

19 MR. BOTHA: Yes, I can't give you the
20 exact number except for the principle and the
21 principle is if you're down to 200 kilowatts, there is
22 not a mechanism that leads to core damage.

23 MEMBER POWERS: I can always find
24 mechanisms to get to core damage for any state. It's
25 just how likely are they?

1 MR. BOTHA: That's right.

2 So --

3 MEMBER POWERS: And, it seems to me, this
4 is one of those things that just begged for a risk
5 assessment.

6 And, I mean, I just can't imagine how I
7 would make a decision on this --

8 MR. BOTHA: Sure.

9 MEMBER POWERS: -- without a fairly
10 transparent risk assessment on this.

11 MR. BOTHA: Sure.

12 MEMBER POWERS: It's because you say,
13 okay, something's gone wrong, as soon as something's
14 gone wrong then I know lots of things can go wrong.

15 MR. BOTHA: We haven't any core damage
16 frequency -- core damage mods from this condition, but
17 that's certainly something you could question as you
18 get into that part of the review.

19 So, I think the points on this slide is
20 that the GDCs, so, if you look at the criteria for the
21 exemption, they're conservative both in the terms of
22 requiring CHF.

23 And, once you're looking at CHF, normally,
24 CHF is a requirement for AROs. So, if you have an
25 ARO, you don't need to meet CHF, so requiring that you

1 need to meet CHF and limit the event to be less
2 frequent than an ARO so that there's not expected in
3 the life of the plant, I think is a conservative
4 requirement with respect to GDC 27.

5 So, that's on the criteria.

6 With regards to design evaluation, I think
7 we want to try and focus on this with respect to the
8 criteria and just look at some of the differences
9 between our Chapter 15 evaluation and the
10 probabilistic evaluation or the realistic evaluation,
11 if I may, just because I think that provides some
12 context.

13 But, the detail for this certainly will
14 come out as you get into the Chapter 15 review and the
15 SER for Chapter 15. For example, when we get to
16 Chapter 19 review.

17 So, just going over these two evaluations,
18 I think what's important on looking at the
19 deterministic evaluation first, is just in terms of
20 big picture -- the bigger picture.

21 If you look at how events are analyzed in
22 Chapter 15 and what the criteria are for analyzing
23 those events, being shutdown is not a specific
24 acceptance criteria in Chapter 15.

25 So, what I mean by that is, you get some

1 of the events that, for example, for BWR, inadvertent
2 pressure relief valve actuation where the reactor is
3 not even tripped.

4 So, it is not a requirement that you have
5 to trip the reactor for your Chapter 15 events, so for
6 that specific event, the reactor stays at power. And,
7 you then evaluate the CHF or the fuel for that event
8 for a BWR.

9 That's just an example, but if you look at
10 the acceptance criteria, they're really focused on
11 providing conservative assumptions to -- and bounding
12 analysis to demonstrate that you do not exceed CHF or
13 exceed the pressure limits on your primary system for
14 AROs.

15 And then, that you maintain your critical
16 core geometry for accidents.

17 So, that's the focus of Chapter 15. And,
18 we'll -- we're going to get into a little bit for
19 large PWRs, why you get acceptance criteria or you
20 have to be shutdown when you demonstrate those
21 analysis. And, that's really looking at from a
22 functional perspective as opposed to the requirements
23 section perspective, which I'm sure the staff will
24 point out from a precedent.

25 And, that's the whole point, from a

1 precedent perspective, we are unique such that, if you
2 make these Chapter 15 assumptions, then you see this
3 return to power.

4 So, what -- from the Chapter 15
5 perceptive, let's look at what those conservative
6 assumptions look like.

7 So, the first one is the worth rod stuck
8 out. That is not a single failure criterion, that's
9 one of the assumptions that you have to make as part
10 of your analysis and that's per the GDCs.

11 The next one is the moderator temperature
12 coefficient. So, you usually make a bounding
13 assumption in terms of what your moderator temperature
14 coefficient is, that's pretty typical for Chapter 15.

15 Then, your cooldown rate, so you look at
16 maximum cooldown rates. So, xenon and boron
17 concentration, so your xenon that you assume and the
18 boron concentrations you assume are all bounding.

19 And then, again, no credit for your non-
20 safety systems.

21 So, if you make those assumptions, what
22 you find is that you will have a return to power for
23 every event. And, that's because of the assumptions
24 you make.

25 Now, what's the probability that those

1 conditions or assumptions will actually occur? Well,
2 that's effectively zero. You'll not see those
3 assumptions under real-life conditions.

4 In terms of the event progression, so,
5 what you then see with those conservative assumptions
6 is you have a return to power about two-plus hours
7 with a DHRS cooldown.

8 We went through the -- what the -- and the
9 staff may do it, I'm not sure, I haven't seen their
10 presentation, but we went through that previously --
11 for the previous presentation.

12 And then, at some point, you'll transition
13 to your ECCS. And, that depends on whether you have
14 power or not. So, if you lose DC power, you assume
15 you've lost DC power, then you will transition to ECCS
16 before 24 hours. If you have DC power, we have
17 automatic means of transitioning to ECCS at 24 hours,
18 and that's to preserve power on the batteries.

19 And then, with -- once you're on ECCS, the
20 limiting condition with respect to internal is really
21 being that maximum decay heat rather than -- and then
22 you'd be subcritical.

23 So, being subcritical with maximum decay
24 heat is really the limiting condition with regards to
25 ECCS internal.

1 And, again, the criteria for this that the
2 staff requires is the CHF. So, we do the safety
3 evaluation, demonstrate that whether this is safe or
4 not. The CHF limits might exceed it.

5 In terms of the probabilistic evaluation
6 and also the more realistic evaluation, we still made
7 -- so when went over the three contributions to the
8 ten to the minus below -- less than ten to the minus
9 six probability for this event in the Subcommittee
10 meeting, we haven't gone through the assumptions and
11 there's some conservative assumptions in terms of how
12 we evaluated it.

13 The first one is pretty important, I
14 think, in terms of some of the questions the ACRS has
15 raised. And, that is, we assume that the failure
16 probability for the CVCS, which I think is in the
17 order of ten to the minus three, is really the
18 unavailability on demand.

19 So, that does not take into account that
20 when you had a demand fail, that you can bring it back
21 online when you have time. And, that's a pretty
22 important point.

23 There's a big difference between the
24 failure on demand probability for equipment as opposed
25 to, well, will this equipment be out of service for 30

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 days?

2 MEMBER STETKAR: Derick, please don't
3 lecture the Committee on PRA. We would like to see
4 your PRA.

5 MR. BOTHA: I understand.

6 MEMBER STETKAR: And review how you've
7 evaluated the full spectrum of scenarios that could
8 lead to the condition and the consequential
9 reliability of all of the possible systems, including
10 operator actions and the time available for those
11 actions.

12 Everything else that you say is pure
13 speculation at this point.

14 MR. BOTHA: From the Committee's
15 perspective.

16 MEMBER STETKAR: From the Committee's --
17 from my personal perspective, the Committee -- I don't
18 speak for the Committee.

19 MR. BOTHA: Yes.

20 MEMBER STETKAR: For example, in your
21 assertion on this slide that CVCS failure on demand is
22 more likely than an extended unavailability of both
23 CVCS and CFDS.

24 We have documented PRA experience to show
25 that there are more likely scenarios that take out

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 several systems if you do an integrated PRA.

2 It's why, for example, currently operating
3 plants installed systems like AMSAC, installed
4 alternate rods injection --

5 MR. BOTHA: Sure.

6 MEMBER STETKAR: -- for BWRs because those
7 combinations of AOOs, like a loss of main feed water
8 in combination with common cause failures, indeed,
9 were more likely than the assumed single failures in
10 your safety analysis.

11 So, don't lecture us on PRA. We want to
12 see your final PRA. And, until this Committee has the
13 opportunity to see that PRA, anything that you say
14 about numbers is kind of a waste of our time.

15 That's my own personal perspective, but --

16 MR. BOTHA: Thanks.

17 MEMBER STETKAR: -- to keep us on track.

18 MR. BOTHA: I would like to respond to
19 that, but I'm cautious of the time.

20 CHAIR CORRADINI: You should be.

21 MR. BOTHA: Yes, thank you.

22 So, I think just going through this -- I
23 think I've gone through the conditions. I'm not going
24 to go through the rest of the probabilistic evaluation
25 because I've covered that on a previous slide, so I'm

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 going to the next slide.

2 MEMBER MARCH-LEUBA: Before we run out of
3 time and they don't let me ask you a question, can you
4 go forward to slide 12, one of the backup slides?
5 Because I know I'm being polite, I kept quiet and then
6 when I ask a question, he doesn't let me ask it.

7 (LAUGHTER)

8 MEMBER MARCH-LEUBA: Unequivocal.

9 So, the CVCS injects into the vessel,
10 correct?

11 MR. BOTHA: Yes.

12 MEMBER MARCH-LEUBA: What's the location
13 of injection? It's above or below the core?

14 MR. BOTHA: Above the core.

15 MEMBER MARCH-LEUBA: It's above the core?

16 MR. BOTHA: Yes.

17 MEMBER MARCH-LEUBA: That's good.

18 The issue that I think has been raised and
19 I believe is under ECCS conditions when you're
20 depressurizing, you don't have any flow, then you will
21 inject CVCS on the boarder, we've got the lower
22 plenum.

23 MR. BOTHA: Yes.

24 MEMBER MARCH-LEUBA: Are easier to put in
25 the upper plenum.

1 MR. BOTHA: Yes.

2 MEMBER MARCH-LEUBA: So, it will go
3 through the core as it goes down.

4 MR. BOTHA: Yes.

5 MEMBER MARCH-LEUBA: So, for March 22nd
6 and the next two years, we are going to be asking
7 about boron certification a lot. Just giving you a --
8 I mean, this is not what we're doing now, but there is
9 a high -- a significant, a non-zero likelihood --

10 MR. BOTHA: Sure.

11 MEMBER MARCH-LEUBA: -- that your backup
12 system, the CVCS does not work under ECCS conditions.

13 No need to answer me now, I'm just giving
14 you a --

15 MR. BOTHA: We can also insert that with
16 a spray line as well, which is also above the core.

17 MEMBER MARCH-LEUBA: But, make a note on
18 our description March 22nd to cover that.

19 MR. BOTHA: Thank you.

20 So, if I can go schematically --

21 MEMBER MARCH-LEUBA: Another factor, can
22 you go to the slide, the next one, I know it's about
23 13.

24 The reactor pool water, you see borated?

25 MR. BOTHA: Yes.

1 MEMBER MARCH-LEUBA: And, there are
2 positive steps to keep it soft? I mean, is it in the
3 tech specs that you will keep it --

4 MR. BOTHA: I don't know.

5 (SIMULTANEOUS SPEAKING)

6 MR. BOTHA: I mean, it's connected to the
7 spent fuel pool.

8 MEMBER MARCH-LEUBA: Because, if you go to
9 the slide 14, when those valves open, you have the
10 possibility of injecting that water into the core, the
11 reactor pool.

12 MR. BOTHA: No.

13 MEMBER MARCH-LEUBA: On the next slide.

14 MR. BOTHA: No.

15 MEMBER MARCH-LEUBA: The valves are now
16 open.

17 MR. BOTHA: No, that's the containment
18 vessel is isolated from the pool.

19 MEMBER MARCH-LEUBA: Does it?

20 MR. BOTHA: Yes.

21 MEMBER MARCH-LEUBA: Okay, it might. I
22 can see you wrestle with it.

23 MR. BOTHA: Okay.

24 MEMBER MARCH-LEUBA: But, we will want to
25 review that during the next couple of years.

1 MR. BOTHA: Sure, but I understand the
2 concept, thank you.

3 MEMBER MARCH-LEUBA: But, I did --

4 CHAIR CORRADINI: The engineers want to
5 know more.

6 MR. BOTHA: Yes.

7 CHAIR CORRADINI: Okay, back to your --

8 MR. BOTHA: In terms of the design
9 evaluation, I think this is a -- I'm going try and hit
10 the high level --

11 The big picture in terms of this slide is,
12 I previously made the point that compared to PWRs, we
13 have redundant means for shutting down the core. So,
14 they need both the rods and injection, we can do it
15 with either one of the two.

16 An additional level of safety that we add
17 with our design, and that's because of the low power
18 entity in the core to some extent, is that when you
19 have a single rod stuck out or multiple rods stuck
20 out, so if you're going to -- so this type of
21 scenario, the natural -- the passive means of the
22 decay heat removal systems and the physical phenomena
23 that drives reactivity in the core is such that you're
24 always able to remove the heat.

25 So, even if you do not shutdown and you're

1 not relying on your reactivity control systems,
2 there's inherent means for core protection in this
3 design.

4 So, I think the one -- and then I'll --

5 CHAIR CORRADINI: And, can I summarize
6 what I think you just said? You don't need operator
7 action to deal with an that? That's what I think you
8 just said.

9 MR. BOTHA: That's right.

10 CHAIR CORRADINI: Okay, fine.

11 MR. BOTHA: And, again, we would have
12 operators and they would react, but you won't have to
13 allow them.

14 CHAIR CORRADINI: Fine.

15 MEMBER SKILLMAN: Derick, you reference
16 again and again you've got two shutdown systems,
17 you've got the rods and you've got CVCS.

18 MR. BOTHA: That's correct.

19 MEMBER SKILLMAN: And, I would just
20 observe that CVCS may be effective at one point in a
21 cycle and not very effective later in the cycle.

22 The lower the boron concentration becomes,
23 the more you are dependent upon natural circulation to
24 provide mixing.

25 And, Mike Snodderly had forwarded you the

1 comment I made, I'll be curious for the analysis that
2 shows your capability to use CVCS to raise boron
3 concentration to that level that provides the hold
4 down that compensates for the stuck rod.

5 My hunch is that the natural circulation
6 rate is generally low and the mass of water into which
7 your delta boron must be injected will be an extremely
8 long time period because you have no forced
9 circulation. It is all convection.

10 MR. BOTHA: Yes, it's --

11 MEMBER SKILLMAN: So, I'm looking for that
12 analysis.

13 MR. BOTHA: Yes, and I think the short
14 answer for today is, it's long, but it's small in
15 comparison to the time you have before you get to
16 return to power condition.

17 But, I'll leave you with that thought.

18 MEMBER SKILLMAN: Thank you, okay.

19 CHAIR CORRADINI: For a later analysis
20 discussion.

21 MR. BOTHA: Yes.

22 MEMBER SKILLMAN: Yes.

23 MR. BOTHA: So, I think with -- yes, so
24 let's try and finish on time.

25 I think -- so, let's just summarize, I'm

1 not sure it's -- I think the one point I'll just make
2 on the last slide is, for the existing plants, part of
3 the reason, if you look at their ECCS type heat
4 removal requirements, it's very important for the
5 PWRs, and you mentioned TMI experience in terms of the
6 operators being very concerned about whether the plant
7 is shutdown or not.

8 And, there's a different concern in those
9 types of plants, and that is, if you're not shutdown,
10 the heat removal systems for those plants are designed
11 such that it can remove decay heat and no more.

12 And, because its active system do not
13 shutdown then you try and cool the system, it's just
14 going to give you more heat. So, you over-burden your
15 heat removal systems if you're not shutdown for
16 existing PWR, which is not the case for NuScale.

17 So, for those plants, it's very important
18 that when you're on those safety systems, that you're
19 sure you're shutdown, because, if you're not, you're
20 going to get core damage which is different from the
21 NuScale case because you're not concerned about core
22 damage.

23 So, that is not to say that we don't have
24 the operators, and effect that what you find is how --
25 there's a lot of interesting features of our design

1 that leads to a far more reliable active systems
2 because you have all of this time because they are
3 simple systems, the active systems, they are not as
4 critical as in terms of how you have to get your ECCS
5 sequencing right for a large break LOCA, for example.

6 So, you actually need more reliable, non-
7 safety active systems in our design, even though in a
8 non-safety related effect, if you call it non-safety
9 it doesn't mean they're not reliable and that you
10 can't use them and that the operator is not there.

11 So, just in summary, so we'll be pursuing
12 an exemption from GDC 27 consistent with the NRC staff
13 position. So, we've selected our reactivity control
14 systems to be consistent with our overall design
15 philosophy of a passive, simpler system that increases
16 the safety of the plant and we've provided rapid
17 shutdown with our control rods and that's sufficient
18 to protect the fuel.

19 And, we have more than enough reliable
20 capability to maintain subcritical condition --
21 maintain the reactor at subcritical under cold
22 conditions and I've covered the passive heat removal
23 that protects against control rod malfunctions and
24 that's not only for a stuck rod, but for multiple
25 stuck rods.

1 We went -- from the previous presentation,
2 we went through the advanced reactor quality
3 statement. And, for that specific statement to
4 demonstrate that our design philosophy and design
5 options we've selected is consistent with the advanced
6 reactor policy statement of the NRC.

7 And, I think in summary, I'd just like to
8 state that, so, if you look at the probability of this
9 event, it's less probable than a core -- than a core
10 damage frequency on an existing plant. So, it is not
11 that, even though it's such a low probability, there's
12 no potential for radiological consequences under those
13 conditions.

14 It's cold conditions, it's very low power.
15 It's far less taxing on the fuel than your normal
16 operating conditions. So, if you look at our
17 reactivity control systems, and we went some of the
18 precedence, they're more reliable than what the
19 existing fleet provides in terms of shutdown
20 capability.

21 And, they're -- and then, even if they are
22 not there, we've got additional safety built into the
23 system because of the near and passive nature of our
24 advanced systems.

25 MR. GARDNER: I just wanted to go back on

1 the question about GDC 34 that we got earlier. I do
2 have an answer for that.

3 And, specifically, GDC 34 was related to
4 decay heat removal systems. And, the -- we did take
5 exemption from the electrical power aspects of those.
6 I remembered there was a series of GDCs that we needed
7 to exempt.

8 But, it was from the portion of the GDC
9 that included reliance of safety related power which
10 we don't have in this design. So, it wasn't related
11 to the heat removal process.

12 MEMBER KIRCHNER: I don't mean to get into
13 an open discussion on this, but are there any other
14 GDCs that you're going to take an exemption to?

15 CHAIR CORRADINI: We should get that
16 information to the Committee.

17 MEMBER KIRCHNER: We said get it as a
18 Committee because then, you look at a more holistic
19 approach to their PDCs than --

20 CHAIR CORRADINI: I'll make note --

21 MEMBER KIRCHNER: -- coming to us one by
22 one.

23 Thank you.

24 MEMBER REMPE: Well, then they didn't
25 really want to -- the exemption for this one so they

1 may have some that they didn't really want that they
2 get forced into.

3 And, I -- so that list ought to include
4 the whole --

5 MEMBER BLEY: Yes, we get a list of all
6 the exemptions.

7 MEMBER REMPE: And, then if there's some
8 questions with respect to the staff saying, no, you
9 may need one on this, too.

10 MEMBER MARCH-LEUBA: Can I summarize the
11 event we're worried about? And, correct me if I'm
12 wrong, we need to lose offsite AC power because, if we
13 had AC power, we would have injected boron.

14 You have to lose any non-safety related AC
15 power inside the plant because, if you had it, you
16 would have injected boron.

17 And then, you have to fail the most
18 reactive rod. And, you have to be towards the end of
19 the cycle where you're see is --

20 So, if all those four conditions happen --

21 MR. BOTHA: And, you have to be on low
22 decay heat relating cycle, which you wouldn't have for
23 most cycles.

24 MEMBER MARCH-LEUBA: But, you will get
25 that.

1 MR. BOTHA: Yes.

2 MEMBER MARCH-LEUBA: I mean, to get here,
3 we'll look at --

4 MR. BOTHA: Also, a very long time.

5 MEMBER MARCH-LEUBA: So, I'm wondering if
6 we have more than one assumed failure? I mean, you're
7 supposed to have single failure not parts.

8 MR. BOTHA: That's right.

9 MR. GARDNER: I think that was the point
10 on this slide where we said Chapter 15 space, the
11 probability is one because it's deterministic.

12 MEMBER MARCH-LEUBA: Yes, so, I wanted to
13 make sure I didn't misunderstand it.

14 CHAIR CORRADINI: Okay, so, I'm going to
15 thank you. I think we're okay with the other members.
16 Are there other last minute questions?

17 Thank you very much.

18 Sure, go ahead.

19 MEMBER DIMITRIJEVIC: Can your charging
20 system operate with loss of offsite power?

21 MR. BOTHA: Yes.

22 MEMBER DIMITRIJEVIC: If you lose that --
23 because you just said something about the isolation of
24 containment which made me look and that was --

25 MR. BOTHA: You wouldn't isolate

1 containment on the loss of offsite power.

2 MEMBER DIMITRIJEVIC: Okay.

3 MR. BOTHA: In fact, our system is
4 different in that you're not relying on offsite power
5 --

6 MEMBER DIMITRIJEVIC: No, no --

7 MR. BOTHA: -- to power your onsite
8 systems that are important. You can -- so, the answer
9 is, no, you don't need --

10 MEMBER DIMITRIJEVIC: So, your charging is
11 supplied from the diesel generators and things like
12 that?

13 MR. BOTHA: Can be.

14 MEMBER DIMITRIJEVIC: Can be? All right.
15 What is the sort of as John said, that we have to see
16 assumptions in your --

17 MEMBER MARCH-LEUBA: Probabilistic.

18 CHAIR CORRADINI: Okay, we'll make a
19 switch over to the staff.

20 (OFF MICROPHONE COMMENTS)

21 CHAIR CORRADINI: Green light.

22 MR. SCHMIDT: This is actually from --
23 leftover from yesterday.

24 (LAUGHTER)

25 MR. SCHMIDT: Recycling.

1 Yes, I'm sorry, we don't have the
2 presentation up for the screen, so we're going to have
3 to go by the paper copy.

4 CHAIR CORRADINI: So, all the Committee
5 have the slides in front of them, he's going to go and
6 tell us what slide to look at.

7 MR. SCHMIDT: Yes.

8 So, my name is Jeff Schmidt from the
9 Reactor Systems Group. And, Tim Drzewiecki will be
10 helping me with this presentation.

11 Basically, it's the same presentation I
12 gave to the Subcommittee except for one slide change
13 on slide six, and we'll talk about that because there
14 was some confusion. I thought I would just try to
15 address that.

16 So, this is, again, the staff's criteria
17 that we're going to be using for the exemption request
18 for GDC 27.

19 MEMBER RAY: Can I just underscore
20 something?

21 MR. SCHMIDT: Sure.

22 MEMBER RAY: Criteria that you will be
23 using?

24 MR. SCHMIDT: Yes.

25 MEMBER RAY: And, we all need to keep that

1 in mind.

2 MR. SCHMIDT: That's correct, that's what
3 we're proposing.

4 MEMBER RAY: We're not talking about what
5 the answer is in this time.

6 MR. SCHMIDT: No, what's proposed in the
7 SECY paper. Thank you.

8 MEMBER BLEY: And, that's what you want a
9 letter on are the criteria reasonable?

10 MR. SCHMIDT: That's right. That's
11 correct.

12 MEMBER RAY: You don't want us to tell you
13 what the results of apply of the criteria must be, but
14 --

15 MR. SCHMIDT: I propose we not do that.

16 MEMBER RAY: What the criteria are?

17 MR. SCHMIDT: Yes, that's -- let me make
18 that clear, it's the criteria.

19 MEMBER RAY: Well, we've had a little
20 confusion about that.

21 MR. SCHMIDT: It's the criteria.

22 So, I guess I'll just go over the purpose,
23 which is I think we just discussed, brief the ACRS on
24 the acceptance criteria the staff plans on using to
25 evaluate the NuScale exemption to GDC 27, to monitor

1 activity control system capability as described in the
2 staff's draft Commission paper.

3 MEMBER STETKAR: Jeff, my hearing is
4 getting bad, can you pull the mic closer to you or
5 scream at it? Thanks.

6 CHAIR CORRADINI: Older people need that
7 sort of assistance.

8 MR. SCHMIDT: I think I'm there, too.

9 MEMBER STETKAR: Ey, sonny?

10 CHAIR CORRADINI: Okay, go ahead.

11 (OFF MICROPHONE COMMENTS)

12 (LAUGHTER)

13 MR. SCHMIDT: So, quick technical
14 background. I think NuScale covered a lot of this,
15 so, I'm going to go pretty quickly through this.

16 Late in the pre-app the staff learned the
17 NuScale reactor would return to and sustain fission
18 power.

19 MEMBER RICCARDELLA: Your slides aren't
20 up.

21 CHAIR CORRADINI: I know, he just said
22 that we don't have them.

23 MEMBER RICCARDELLA: Oh.

24 (LAUGHTER)

25 CHAIR CORRADINI: Slide three, yes, in

1 front of us.

2 MR. SCHMIDT: Thank you, slide three.

3 Under Chapter 15, Design Basis Assumptions
4 and it's under Chapter 15 Design Basis Assumptions is
5 the key word there.

6 Assumptions include a stuck rod, which
7 we've talked about. It's consistent with the current
8 GDCs.

9 Loss of AC power, the non-safety related
10 CVCS system and sufficiently negative MTC are the
11 criteria that really drive this.

12 Using design basis assumptions, return to
13 power will occur following most AOOs and postulated
14 accidents in the long-term.

15 So, any -- most of the transients in
16 Chapter 15 could eventually lead to this state.

17 CHAIR CORRADINI: With the DBA
18 assumptions?

19 MR. SCHMIDT: With the DBA assumptions.

20 CHAIR CORRADINI: Okay.

21 MR. SCHMIDT: The DBA assumptions --

22 CHAIR CORRADINI: I just wanted to make
23 sure we're --

24 MR. SCHMIDT: -- should never be
25 forgotten.

1 CHAIR CORRADINI: Okay, fine.

2 MR. SCHMIDT: With those assumptions --

3 (OFF MICROPHONE COMMENTS)

4 MR. SCHMIDT: So, maximum -- again, with
5 the DBA assumptions, maximum core return to power is
6 approximately 9 percent, peak pin power and the
7 location of the stuck rod can be up to 50 percent I'm
8 going to kilowatts per foot basis.

9 The design remains subcritical if all
10 control rods insert.

11 MEMBER MARCH-LEUBA: Just a minor --
12 NuScale is saying that MTC is sufficient peak only
13 towards the end of the cycle was the staff does not
14 agree with it?

15 MR. SCHMIDT: I'm not sure we're there
16 yet.

17 MEMBER MARCH-LEUBA: Okay, so, can --

18 CHAIR CORRADINI: Can you repeat that,
19 Jose, I didn't catch.

20 MEMBER MARCH-LEUBA: The -- Nuscale claims
21 that the MTC is sufficient is in the -- it fails to be
22 sufficient at the end of cycle, on the last 30
23 percent. This slide says it's most of the time.

24 MR. SCHMIDT: Right.

25 So, there is some discussion.

1 MEMBER MARCH-LEUBA: You don't have a
2 disagreement, you just don't have a concurrence?

3 MR. SCHMIDT: That's correct.

4 MEMBER REMPE: Is there a discussion in
5 part of this about how much data they need to provide
6 to give folks confidence in that? Is it lack of data
7 or is it -- why is there discussion?

8 MR. SCHMIDT: It's a function of what
9 you're going to assume MTC value to be which changes
10 on a core reload basis.

11 MEMBER REMPE: But, there's confidence,
12 it's just you would end up with additional
13 requirements on a core reload is what you're saying?

14 MR. SCHMIDT: That could be a path
15 pursued.

16 MEMBER REMPE: Okay.

17 MR. SCHMIDT: That is --

18 (OFF MICROPHONE COMMENTS)

19 MEMBER REMPE: No, they could put
20 additional requirements on the reload, not require
21 additional data. They're not talking about a
22 prototype demo, they're just saying we may be more
23 limiting on what they would do during a reload is what
24 I'm hearing from them.

25 MR. SCHMIDT: For the MTC, but there is a

1 phenomena we're looking at that NuScale may have data
2 to support that we may be requesting. To kind of go
3 with your testing.

4 MEMBER REMPE: Yes, there's maybe testing,
5 but I'm not hearing any -- I mean, there's been other
6 cases in history where the staff has said, I might
7 like to see prototype demonstration, that would really
8 set things off in a hurry. And, that's not coming up
9 in the discussions?

10 MR. SCHMIDT: No.

11 MEMBER REMPE: Okay.

12 MR. SCHMIDT: No, it has not yet.

13 Slide four, please?

14 General Design Criteria 27 states
15 reactivity control systems shall be designed to have
16 a combined capability in conjunction with poison
17 addition by the emergency core cooling system of
18 reliably controlling reactivity changes to assure
19 under postulated accident conditions and with
20 appropriate margin for stuck rods, the capability to
21 cool the core is maintained.

22 So, the staff, in its review, as you heard
23 this morning, you know, NuScale's view on it was that
24 the plain language reading of GDC 27 would not require
25 you to get to shutdown in the long-term.

1 The staff disagreed with that and focused
2 that the reliably controlling reactivity really meant
3 shutdown in the long-term. And, there's what's
4 described a little bit this morning is, if you look at
5 the whole structure of the GDCs, it kind of implies
6 shutdown in the long-term. So, that's where the staff
7 was focused on.

8 Again, in support of the staff, the SECY-
9 94-084 policy and technical issues associated with the
10 regulatory treatment of non-safety systems in a
11 passive plant provided additional information to the
12 staff.

13 It says that conditions other than cold
14 shutdown may constitute safe shutdown as long as the
15 reactor subcritical decay heat removal and radioactive
16 materials containment are properly maintained in the
17 long-term.

18 So, again, we focused on reactor
19 subcriticality.

20 Then, you look at the definitions --

21 MEMBER BROWN: Can I --

22 MR. SCHMIDT: Sure.

23 MEMBER BROWN: I just want to clarify that
24 for myself. If -- that goes along with the idea that
25 shutdown means subcritical as well as coolable?

1 MR. SCHMIDT: That's correct.

2 MEMBER BROWN: Okay, just wanted to make
3 sure.

4 CHAIR CORRADINI: And, in that --

5 MEMBER BROWN: What?

6 CHAIR CORRADINI: But, there's more to it.
7 He's quoting part of the --

8 MEMBER BROWN: The SECY --

9 CHAIR CORRADINI: -- 94-084, but if you go
10 back to 94-084, it also says that this could be
11 accomplished. You don't necessarily need to
12 accomplish this only with safety grade systems.

13 MR. SCHMIDT: Safe shutdown, you need
14 safety related systems. Cold, you do not necessarily.

15 CHAIR CORRADINI: Historically?

16 MR. SCHMIDT: Historically, yes, that's
17 true.

18 CHAIR CORRADINI: Okay.

19 MR. SCHMIDT: Historically.

20 CHAIR CORRADINI: That's right, I just
21 wanted to make sure.

22 MR. SCHMIDT: I think the SECY helps
23 clarify that.

24 MEMBER RAY: Clarify it in the -- is there
25 a change in criteria to reflect that clarification or

1 what?

2 MR. SCHMIDT: I think, for me, the SECY
3 clarifies it in the fact that safety related are
4 necessary to get to safe shutdown. Cold shutdown can
5 be used in non-safety systems.

6 MEMBER RAY: And, is that part of the
7 criteria that we're reviewing then?

8 MR. SCHMIDT: No.

9 MEMBER STETKAR: Is that accurate?
10 Because 94-084 addressed the notion of RTNSS. I mean,
11 one of the RTNSS stuff addressed ATWS. And the RTNSS
12 stuff is non-safety related as are all of the fact
13 that AMSAC systems or, you know, whatever they call
14 them, boilers, ARI and that kind of stuff.

15 So, is it accurate to say that safe
16 shutdown must be achieved using safety related
17 equipment consistently with the notion of that SECY
18 paper?

19 MR. SCHMIDT: I think with -- you're also
20 bringing 50 point -- 10 CFR 50.2 it says basically
21 shutdown is safe shutdown.

22 MEMBER STETKAR: It says safe shutdown,
23 but it doesn't say I have to achieve it using safety
24 related --

25 MR. SCHMIDT: Well, that's in pumps and

1 pipes and validated equipment.

2 CHAIR CORRADINI: Say that again, Jeff,
3 please?

4 MR. SCHMIDT: The definition of the -- so,
5 you look under 50.2, it's the definition of safety
6 related equipment. Right?

7 And, it talks about achieving safe
8 shutdown in 50.2.

9 MEMBER STETKAR: Okay, I'll have to look
10 that up.

11 MEMBER RAY: Yes, I think that's the nub
12 of what has been a discussion item I had earlier is
13 are we making a change here for the first time? And,
14 if so, is it got the visibility it needs to have to be
15 generic? Or, is it a one off change from the past?

16 So, I don't want to divert things here,
17 but it's something I'm kind of soft about.

18 CHAIR CORRADINI: I think we can wait
19 until the discussion. I don't completely appreciate
20 what you just said. I just wanted to make sure that
21 we're clear that you were making the difference
22 between safe shutdown and cold shutdown.

23 MR. SCHMIDT: That's correct.

24 CHAIR CORRADINI: That's where you were
25 going?

1 MR. SCHMIDT: That's correct.

2 CHAIR CORRADINI: Okay.

3 MR. SCHMIDT: As we just talked about, the
4 definition of safety related SSE -- I'm on slide five
5 -- the safety related SSEs in 10 CFR 50.2 state the
6 capability to shutdown the reactor and maintain it in
7 a safe shutdown condition. It doesn't refer to cold
8 there.

9 The NRC has license designs with return to
10 power in the short-term following postulated
11 accidents. We heard that this morning from NuScale.

12 So, the NRC has not licensed a power
13 reactor that does not achieve subcriticality in the
14 long-term using only safety related systems.

15 Again, we talked about that a little bit
16 this morning that the premise of our GDCs assumed, I
17 think, shutdown in the long-term.

18 Staff's responded to NuScale that an
19 exemption to GDC 27 would be required. And, such an
20 exemption would warrant Commission consideration and
21 direction prior to the staff's approval.

22 Slide six.

23 CHAIR CORRADINI: Can you make sure I
24 think I know what that just means. That means, let me
25 put it in a process question.

1 So, we're looking at I bundled those two
2 criteria that you're going to use to evaluate the
3 design as the analysis goes, whether it be the systems
4 or the risk -- the reliability, that's one. And,
5 that's an alert to the Commission, they filed the
6 exemption.

7 And then, once you do the evaluation, it
8 goes back, that's the way I read this, it goes back to
9 the Commission for consideration or you are then free
10 to -- do you know what I'm asking?

11 MR. SCHMIDT: Not exactly, because I'm not
12 overly process familiar so I'm going to turn to --

13 CHAIR CORRADINI: Good, I don't like
14 process, either. I just want to understand what those
15 words meant.

16 MR. SCHMIDT: I think the word -- so,
17 those words meant we would need Commission engagement,
18 nothing more than that.

19 CHAIR CORRADINI: Engagement isn't
20 approval.

21 MR. SCHMIDT: Not --

22 CHAIR CORRADINI: Here's a clarifier --

23 MR. RECKLEY: If I can? What we meant by
24 that --

25 CHAIR CORRADINI: And, you are?

1 MR. RECKLEY: I'm sorry, Bill Reckley from
2 the staff.

3 What we meant by that is, ultimately,
4 because this will either be a licensed facility or a
5 design certification, the Commission will get ultimate
6 approval of this at that stage.

7 CHAIR CORRADINI: Oh, okay. I got it,
8 that's true. Okay, that helps me.

9 I didn't -- okay, thank you very much,
10 Bill.

11 MR. SCHMIDT: Now, on slide six.

12 And, I added this slide just because in
13 the Subcommittee, there was some confusion, I got a
14 lot of questions of what is the exemption, so I tried
15 to clarify it here just for everybody's purpose.

16 The exemption is from the staff's position
17 that reliably controlling reactivities in GDC 27
18 includes the requirement to achieve subcriticality
19 beyond the short-term using only safety related
20 equipment following a postulated accident with a stuck
21 rod.

22 So, that's what the exemption is for.

23 MEMBER MARCH-LEUBA: And, for those of us
24 who don't have a law degree, every light water reactor
25 is required to follow GDCs, all of them, unless they

1 get an exception to one or more GDCs and they propose
2 their own PDCs?

3 MR. SCHMIDT: Yes.

4 MEMBER MARCH-LEUBA: Is that correct?

5 MR. SCHMIDT: That's correct.

6 MEMBER MARCH-LEUBA: So, this will only
7 apply to this particular reactor?

8 MR. SCHMIDT: That's correct.

9 Beyond the short-term means long-term
10 natural equilibrium state achieved by the reactor.
11 So, we're trying to separate out this short-term,
12 long-term issue because PWRs can go potentially
13 recritical in the short-term on a main steam upgrade.

14 MEMBER BROWN: So, I'm sorry, I was trying
15 to make sure I understand where this -- that's your
16 basis for saying why you need an exemption? That's --
17 you're stating that's what it says, the exemption --
18 that's your position that reliably controlling
19 includes this part of it?

20 And, beyond the short-term means this and
21 that's -- therefore, you need an exemption?

22 So, if you end up approving the exemption,
23 you're fundamentally saying that doesn't apply
24 anymore?

25 MR. SCHMIDT: We're saying that it's a

1 valid exemption to -- so, our interpretation stays the
2 same --

3 MEMBER BROWN: You can be critical in the
4 long-term --

5 MR. SCHMIDT: -- exemption --

6 MEMBER BROWN: -- and not as opposed to
7 just the short-term?

8 CHAIR CORRADINI: Can I -- he's nodding.
9 I just want to make sure your question is asked and
10 answered.

11 His -- I thought what you were asking is,
12 when this if, if.

13 MEMBER BROWN: If, that's correct.

14 CHAIR CORRADINI: And, the analysis is
15 presented and if the staff thinks the analysis, after
16 evaluation, is acceptable for NuScale, they would
17 essentially propose a different way to satisfy this
18 which are not necessarily say with a set of
19 assumptions, I can only use safety grade equipment to
20 achieve subcriticality.

21 MR. SCHMIDT: Right. And, the
22 subcriticality part is the part that is in question.
23 Right? That's the exemption.

24 MEMBER BROWN: Okay, but I still am fuzzy.
25 If you go back to their discussion, I'm trying to

1 remember this, it's not just that they achieve it with
2 non-safety related stuff, it wasn't clear, at least
3 based on their presentation, to me, that the non-
4 safety related stuff would then come -- would fulfill
5 that.

6 In other words, the CVCS may or may not be
7 needed. Because, it's just sitting there perking
8 along and nobody cares.

9 MR. SCHMIDT: So, when they --

10 MEMBER BROWN: And, they're critical and
11 generating power in whatever level that power is.

12 MR. SCHMIDT: Yes.

13 So, you've got to kinda break it into two
14 separate thoughts. The Chapter 15 analyses only
15 credits safety related systems to mitigate upset
16 conditions, AOOs postulated accidents.

17 So, the CVCS is a non-safety system. So,
18 from a Chapter 15 standpoint --

19 MEMBER BROWN: For NuScale, it's a non-
20 safety system?

21 MR. SCHMIDT: Yes, yes.

22 It doesn't exist to me. It's not credited
23 to mitigate a Chapter 15 event. Does it still exist?
24 Yes. Could it be capable of injecting boron? Maybe,
25 maybe not, whether it's isolated power, there's a lot

1 of assumptions there. Right?

2 But, in Chapter 15, it does not exist to
3 me.

4 MEMBER BROWN: Yes, I got that part. So,
5 it's only the rods and then they live with whatever
6 criticality they get?

7 MR. SCHMIDT: Whatever comes out of it.
8 That's correct.

9 MEMBER BROWN: That part I get. So, but,
10 if you end up approving, you go through your analysis
11 and you determine that, yes, their argument in the
12 other column that they had over there on slide
13 whatever it was, 9 or 10 or 8, what have you, that
14 would fundamentally redefine -- allow you to not
15 comply with this specific interpretation of GDC?

16 MR. SCHMIDT: It is an exemption to that
17 GDC.

18 MEMBER BROWN: Or position. Yes, well,
19 it's really a big policy issue.

20 MR. SCHMIDT: And, that's why the policy
21 --

22 MEMBER BROWN: In my own mind, okay,
23 whether -- that's my personal opinion. It's a big
24 policy change.

25 MR. SCHMIDT: And, I --

1 MEMBER BROWN: That you can sit there and
2 perk forever.

3 CHAIR CORRADINI: Well, I mean, just to
4 repeat what I thought I heard in the Subcommittee is
5 Jeff's point is, there are two reasons that they felt,
6 one, by the -- I'll call it by the letter of the law,
7 this was required.

8 But, also, to alert the Commission that
9 this is --

10 MR. SCHMIDT: A policy issue.

11 MEMBER DIMITRIJEVIC: Well, have something
12 also to summarize just to make sure I understand well.

13 There is the two requirements in GDC, I
14 understood it --

15 CHAIR CORRADINI: Green light again.

16 (OFF RECORD COMMENTS)

17 MEMBER DIMITRIJEVIC: Okay, so let me --
18 there is still a requirement. One is to reliably
19 control the activity and one is the capability to core
20 cooling.

21 Chapter 15 specifically mentioned GDC 27
22 for the core cooling. So, when you analyze core
23 cooling, you can use a Chapter 15 assumption, however,
24 for reliably controlling reactivity, there is no
25 anything which tell us that we should assume -- we

1 should only credit safety systems and then we can
2 assume loss of offsite power, things like that.

3 So, I really am not sure I can remake that
4 what you said would you put them reliably to control
5 activity is beyond the short-term and safety related
6 equipment only?

7 And also, some loss of offsite power, I
8 don't know how that affects all the picture because
9 I'm not sure what's happening there, which was also
10 credited.

11 So, Chapter 15 assumptions are used to
12 reliably control activity and may not be the case, we
13 are not sure or do they apply?

14 MR. SCHMIDT: I think, as we kind of went
15 through the regulatory background, that's how the
16 staff got to what was interpreted as reliably
17 controlling reactivity. Right?

18 Reliably controlling reactivity in and of
19 itself, those words are difficult to interpret,
20 nebulous, ambiguous.

21 MEMBER DIMITRIJEVIC: Right.

22 MR. SCHMIDT: So, what we did is we looked
23 at past precedent, we looked at the SECY, we looked at
24 the assumptions of the basic GDCs as was talked about
25 this morning, we looked at the definition of safety

1 related equipment.

2 And, in our determination with working
3 with OGC quite a bit, we took the position that
4 reliably controlling reactivity meant shutdown in the
5 long-term because that's kind of the fundamental bases
6 of our regulations.

7 MEMBER DIMITRIJEVIC: All right. And, you
8 also took out the only safety equipment that could be
9 credited?

10 MR. SCHMIDT: We got the safety related
11 equipment from 50.2 -- 10 CFR 50.2.

12 MEMBER DIMITRIJEVIC: Okay. This is -- so
13 this is your interpretation but you have agreement
14 within the -- that this interpretation is valid?

15 MR. SCHMIDT: We had -- we spent a lot of
16 time with OGC on this. So, this, again, it's based on
17 a universe of things, not an individual data point.

18 So, the staff feels comfortable in its
19 position.

20 MEMBER MARCH-LEUBA: Going back to
21 Harold's and Charlie's comments, the concern I have is
22 we are modifying the GDC 27 specifically for this
23 reactor, nothing -- because we suspect --

24 MR. SCHMIDT: We are taking an exemption
25 to it.

1 MEMBER MARCH-LEUBA: Yes, we're providing
2 an exception when we find -- and they appear you see,
3 only for this here. Are you asking me to judge
4 whether that's okay or not on a reactor that I don't
5 know anything about?

6 MR. SCHMIDT: No, you're --

7 CHAIR CORRADINI: No, you are not being
8 asked to judge the criteria you're going to use to
9 evaluate.

10 MEMBER BLEY: Later, we'll have to see if
11 they actually meet the criteria.

12 MEMBER MARCH-LEUBA: Well, why are we
13 changing the criteria for one particular reactor --

14 CHAIR CORRADINI: Because they've asked.

15 MEMBER MARCH-LEUBA: -- that we don't know
16 anything about?

17 MEMBER STETKAR: No, because they've
18 asked. And they're allowed to ask.

19 MEMBER BLEY: I'd like to make a couple of
20 points.

21 One is, we keep saying Criterion 27 has
22 two requirements, it's not quite the way it's written.
23 It says you must be able to reliably control the
24 reactivity to assure that you can cool the core. That
25 part is to assure you can cool the core.

1 They are saying, even if we don't -- we do
2 that because we are reliably cooling the core, first
3 point.

4 The second point, for anybody who wasn't
5 here yesterday, the advanced reactor design criteria
6 don't exist yet but we were looking at them and there
7 on this issue, the staff is really making their
8 clarification right in the criteria saying they have
9 to reach safe shutdown.

10 But, that isn't in the current GDC.

11 CHAIR CORRADINI: Green light, green
12 light.

13 MEMBER DIMITRIJEVIC: I just want to say
14 I split in two parts, but I believe the main point is
15 to cool the core and that they satisfy that. So then,
16 we -- no, no, I know.

17 CHAIR CORRADINI: But, the other thing is
18 just --

19 MEMBER DIMITRIJEVIC: None of the
20 expression --

21 CHAIR CORRADINI: I'm sorry -- I didn't
22 mean to interrupt you.

23 The other thing, Dennis, is I think what
24 you said I'd agree with, just to clarify, the safe
25 shutdown is not cold shutdown. That's Jeff's point

1 three slides ago. I just wanted to make sure we're on
2 the same page, that's all.

3 MEMBER DIMITRIJEVIC: But we said
4 yesterday during the discussion, we said that we do
5 not have a firm definition of what safe shutdown and
6 the safe shutdown doesn't necessarily mean safe
7 shutdown safety equipment -- safety related equipment.

8 It just means long-term -- so I agree with
9 him.

10 CHAIR CORRADINI: Is that a question for
11 Jeff?

12 MEMBER DIMITRIJEVIC: No, I just wanted --
13 didn't we bring during yesterday's --

14 CHAIR CORRADINI: Well, I don't want to
15 confuse yesterday with today, that's what I'm --
16 yesterday doesn't really exist, that's something
17 that's going on in parallel.

18 MEMBER DIMITRIJEVIC: Well, maybe we can
19 again ask for definition of safe shutdown.

20 MR. SCHMIDT: Yes, it's subcritical with
21 adequate heat removal with safety related equipment.

22 MEMBER DIMITRIJEVIC: Does it say it's
23 safety related equipment and where does it say that?

24 MR. SCHMIDT: On 10 CFR 50.2.

25 MEMBER DIMITRIJEVIC: It says it's safety

1 related?

2 MR. SCHMIDT: It's the definition of
3 safety related equipment, what its function is.

4 MEMBER RAY: That's how you define safety
5 related.

6 MR. SCHMIDT: Yes, right.

7 MEMBER RAY: It's required for safe
8 shutdown.

9 MEMBER BROWN: And, you say shutdown, it
10 theoretically is cooling as well as subcriticality.

11 MR. SCHMIDT: Yes, yes.

12 MEMBER BROWN: Then that's specifically --

13 MEMBER BLEY: Not theoretically.

14 MEMBER BROWN: I used the wrong word, I
15 agree with you.

16 MEMBER BLEY: But, it doesn't mean cold
17 shutdown --

18 MEMBER BROWN: I understand that.

19 MEMBER BLEY: -- for AP1000.

20 MEMBER BROWN: Yes, I understand that
21 point.

22 MEMBER RAY: It just --

23 MEMBER BROWN: I'm just trying to wrap my
24 head around the fact that whatever you set your
25 criteria and if we write a letter agreeing with your

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 criteria, that'll fundamentally puts us on the
2 position that we're going to eventually agree if you
3 come up with your analysis that it's okay to sit there
4 and cook forever.

5 But, I'm using that --

6 MR. SCHMIDT: For a longer period of time
7 that --

8 MEMBER BROWN: Very long period of time
9 potentially.

10 CHAIR CORRADINI: Under DBA assumptions.

11 MR. SCHMIDT: Under DBA assumptions.

12 CHAIR CORRADINI: Which could be highly
13 lower probability.

14 MEMBER BROWN: Put all that aside, okay,
15 I understand that point. The point is, wrapping your
16 head around the fact that you're going to let --
17 you're going to agree to let a reactor operate and be
18 at power for a long period -- critical at power when
19 you're supposed to be shutdown and you can't control
20 it.

21 MEMBER BLEY: We'll let a reactor melt
22 under some conditions because we call them beyond
23 design basis call nine, two stuck rods maybe.

24 MEMBER BROWN: Yes, but this is not beyond
25 basis, this it what we're dealing with right now.

1 MEMBER BLEY: One could talk about the
2 conditions that exist there, the way we got to this
3 point. You know, when you go back and think about how
4 all this started when we came up with this idea of
5 design basis accidents, and AOOs and transients that
6 happen always.

7 AOOs might happen in the life of the
8 plant, accidents -- design basis accident aren't
9 expected to happen in the life of the plant.

10 But, back then, we said, but they're
11 credible. They could happen. And, some special cases
12 then of accidents we said, well, those aren't
13 credible.

14 Well, you have to think about this one.
15 We got ourselves into this niche of in a certain
16 period of time under various conditions, we're closing
17 out are we reaching a point where, in those days, we
18 would have set aside credible and won't even looked at
19 it.

20 What we have now is a risk assessment that
21 could look at it and tell you how likely it is and
22 what the consequences are, we haven't got to that part
23 yet.

24 MEMBER RAY: I'm not disagreeing at all
25 with what you just said, Dennis. I would just say,

1 when we make the change that you're suggesting, we
2 need to be very clear about it, I think. We're moving
3 from the past to the future and this is when we're
4 doing it rather than just have it happen without
5 making that explicitly clear.

6 CHAIR CORRADINI: Why don't we let him --

7 MEMBER BROWN: One other comment, if I
8 can. When we write our letter, and if we agree with
9 the assumptions of the criteria that they're using and
10 if they come through with an analysis, okay, for
11 NuScale to them, they evaluate it and they say that
12 meets the things we agreed with in our letter, that
13 effectively means we're agreeing with --

14 MEMBER BLEY: Well, we're going to --

15 MEMBER BROWN: -- noncritical --

16 MEMBER BLEY: We're going to evaluate
17 those analyses when we get consultants to help us.

18 MEMBER BROWN: Yes, I understand that.
19 I'm just saying this is a -- to me, it's a very, very
20 steep, slippery slope that we're working with and
21 we've got to be very careful how we do it.

22 It just -- I still have a hard time
23 wrapping my head around a critical reactor for days
24 while it's generating heat.

25 CHAIR CORRADINI: But, under --

1 MEMBER BROWN: Even if it's coolable.

2 CHAIR CORRADINI: I don't want to get into
3 discussion, I want to let you keep on going.

4 MEMBER BROWN: Yes, we can go on.

5 CHAIR CORRADINI: You need to go on.

6 MEMBER BROWN: I'm finished.

7 MR. SCHMIDT: Okay, slide seven, please?
8 Slide number seven.

9 Actually, I want to skip slide seven
10 because we saw this morning -- it's the GDC, let's
11 just move on to eight.

12 Slide eight, staff's review approach,
13 staff applied the enhanced safety focused review
14 approach at the beginning of the review.

15 Identified this issue as receiving more
16 emphasis in terms of review scope and depth compared
17 to the traditional review using our ESFRA tool.

18 I think we've all recognized this is new
19 ground. So, staff is early in the review of the
20 analysis, Phase I. Continues to apply ESFRA in its
21 review.

22 Technical audits of the NuScale analysis
23 is ongoing as well as staff confirmatory analyses.

24 Slide nine?

25 Staff's review and acceptance criteria, so

1 the staff is going to look at it two ways, Chapter 15
2 considers conservative assumption analysis for stuck
3 rods, evaluating the SAFDLs as given by GDC 10 as the
4 acceptance criteria to demonstrate adequate cooling by
5 maintaining the fuel clad fission product barrier.

6 This is consistent with the methodology
7 typically used to analyze PWR main steam line break,
8 short-term return to power.

9 It does not consider the probability of
10 occurrence. In other words, for Chapter 15, the
11 occurrence is one. And then, we evaluate
12 conservatively.

13 The exemption review considers all the
14 above Chapter 15 criteria. Shutdown is maintained
15 assuming all rods inserted and the probability of
16 occurrence is low and not within the lifetime of the
17 module.

18 MEMBER RICCARDELLA: To me, that's very
19 vague, I'll just use the term. I mean, what does that
20 really mean?

21 I mean, if I had a probability of
22 occurrence of .049 per module year, then that
23 translates to 100.49 in a hundred years which is less
24 than .5. So, therefore, it's not expected to occur.

25 I mean, it's just not well defined, that

1 issue. Should we be using a number?

2 CHAIR CORRADINI: You're talking about
3 which one?

4 MEMBER RICCARDELLA: I'm talking the
5 probability of occurrence is low, not expected within
6 the lifetime of a module.

7 CHAIR CORRADINI: I got you.

8 MEMBER STETKAR: Jeff, let me pursue that
9 a bit because if I live next to one of these things
10 and it's got 12 modules in it, and let's presume that
11 all of these are fully independent events that there
12 is no common cause, there's no external events that
13 could affect multiple modules.

14 Wouldn't I be interested as a member of
15 the public that it doesn't occur within the lifetime,
16 at least of the facility, which is 1200 module years,
17 not 100 module years, and I'd want to have pretty good
18 assurance that this is a small contribution to my
19 overall risk from the facility.

20 So, focusing on whatever the lifetime of
21 a module and whatever the probability of occurrence is
22 low, doesn't really tell me anything.

23 MR. SCHMIDT: So --

24 MEMBER STETKAR: And, I do not believe
25 anything that I read in marketing until I see the risk

1 assessment that looks at all of those other events
2 that could, in fact, affect a single module in ways
3 that they haven't thought about or multiple modules in
4 ways that it's not at all clear that they've thought
5 about.

6 So, how does the staff -- I mean, in terms
7 of general principles, I get the general principle.

8 MR. SCHMIDT: Yes, so, the general -- I
9 think that's what the takeaway is, the general
10 principle.

11 We've had a lot of discussion of what to
12 put on this slide.

13 MEMBER STETKAR: Well, it's not only in
14 the slide, but you're asking -- but are you sending it
15 up to the Commission, so you want to make sure the
16 Commission understands what you're talking about.

17 MR. SCHMIDT: I agree with you that it's
18 -- my personal opinion is that it's the facility, so
19 I multiply it times 11 because I usually have one in
20 refueling.

21 So --

22 MEMBER STETKAR: I think of something in
23 refueling as still having the susceptibility to
24 damage. So, I multiply it by 12.

25 MR. SCHMIDT: I don't think any of these

1 --

2 MEMBER STETKAR: So, we're at 9 percent
3 difference.

4 MR. SCHMIDT: Right, and I don't think we
5 were in a position yet to put a more specific number.
6 This can be less than the lifetime of the module and
7 it can be significantly less time than the lifetime of
8 the module.

9 And, I think that just needs to come out
10 of the review.

11 MEMBER RICCARDELLA: Just saying isn't a
12 significant contributor to overall plant risk or
13 something of that sort.

14 MEMBER STETKAR: This is a bit of --
15 again, I personally understand the principle but in
16 terms of the staff's expectation, NuScale's
17 understanding the staff's expectation and the
18 Commission's understanding of your expectation, it's
19 a bit vague.

20 MR. SCHMIDT: It is.

21 MEMBER STETKAR: Yes, if I were NuScale,
22 I'm not sure whether you're asking me to bring a rock
23 or a 100,000 pebbles.

24 MR. SCHMIDT: This is the -- so, this is
25 like the upper bound of it, this isn't -- we wouldn't

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 want to go within the lifetime of the plant. This is
2 like the upper range, not necessarily the lower range.

3 CHAIR CORRADINI: But, I'm listening
4 carefully because we're going to have a discussion
5 eventually about this.

6 So, what I hear you telling me is, this is
7 an upper -- you're using the term upper bound -- this
8 is an upper bound which means you're going to have to
9 evaluate, again, I'm not a PRA person, but I have
10 enough of them in the room they'll tell me, a series
11 of sequences, a series of conditions and then look at
12 the estimates and look at the uncertainty on the
13 estimates and still have a comfortable margin. That's
14 what I -- that's tell me.

15 MR. SCHMIDT: That's where we're going,
16 yes.

17 CHAIR CORRADINI: Okay.

18 MEMBER REMPE: You know, I have documented
19 in the SECY and that's why I've been asking all these
20 questions today. And then, it's not just the
21 frequency of the event, it's what confidence do you
22 have in the heat removal phenomena.

23 And, I mean, there's a lot of, I think,
24 you know, you're going to have to -- I'd like to see
25 more --

1 MR. SCHMIDT: Well, you know, I think
2 we're going to try to address that more in the Chapter
3 15 sense. Right?

4 So, the uncertainties with heat removal
5 capability, you know, we'll use conservative analyses.

6 MEMBER REMPE: To demonstrate adequate
7 cooling by maintaining the fission product barrier.

8 MR. SCHMIDT: Right, so that's --

9 MEMBER REMPE: So, what's adequate? How
10 do I demonstrate adequate cooling and with what
11 confidence?

12 CHAIR CORRADINI: Well, I don't -- I mean,
13 my quick answer is, I've got sufficient margin of CHF.

14 MEMBER REMPE: How much is sufficient
15 margin and what --

16 CHAIR CORRADINI: That's the low likely
17 one.

18 Well, I --

19 MEMBER REMPE: How much margin? I mean,
20 Dana brought up about the conduction phenomena.

21 CHAIR CORRADINI: Currently, the current
22 margin, the current PWR margin.

23 MEMBER REMPE: Okay. So, then, you need
24 to have -- sometimes we talk about with the
25 uncertainty that we consider in LOCA analyses, right,

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 are you going to go to what confident level?

2 CHAIR CORRADINI: Well, I think -- that's
3 what I thought his answer was is that he would
4 essentially use those sorts of --

5 MR. SCHMIDT: We will use a Chapter 15
6 which is recognized to have a lot of conservatism in
7 it.

8 MEMBER DIMITRIJEVIC: When comes to
9 hydraulic and success criteria. So, you want to use
10 success criteria from Chapter 15 and from
11 probabilistic analysis with realistic assumption.

12 Also, I heard probability of occurrence,
13 what does it mean probability of occurrence?
14 Probability of occurrence meaning what? Is this core
15 damage -- is this frequency, first, is it core damage
16 frequency? Is that what is probability of occurrence?
17 What do you mean by probability of occurrence?

18 MR. SCHMIDT: It's the probability of
19 occurrence of return of power. In other words, there
20 are a series of events that have to happen for you to
21 return to power. It's the overall probability of that
22 happening.

23 MEMBER DIMITRIJEVIC: So, probability of
24 returning of power given what?

25 CHAIR CORRADINI: A series of events that

1 he -- that they went through.

2 MEMBER DIMITRIJEVIC: Okay. But, that's
3 means it doesn't take into account initiating
4 challenge frequency, that's extremely important.
5 We're talking about probability.

6 The second thing is, probability of events
7 mean a loss of offsite power, charging, right, so they
8 will have to credit the things which you discredit in
9 Chapter 15. So, do the realistic probability risk
10 assessment, right?

11 That's -- right, so, therefore, you would
12 do the realistic probability assessment, but you will
13 use the thermal hydraulic success criteria from
14 Chapter 15. So, that would be a little mess mush for
15 that.

16 (LAUGHTER)

17 CHAIR CORRADINI: I like that, a mess
18 mush.

19 MEMBER DIMITRIJEVIC: The second thing is
20 that, if you want to call this -- if you want
21 probability of occurrence that mean that probability
22 that it will get back to criticality, that will not be
23 risk measure because risk measures in that PRA
24 probability analysis is core damage frequency and
25 large release frequencies.

1 So, you couldn't account for that risk
2 because according to their analysis, they would never
3 melt.

4 So, now, the question is, what does this
5 -- what do you want this slide to -- I mean, this is
6 not really well defined.

7 MR. SCHMIDT: So, again, the probability
8 of occurrence for my purposes here is the probability
9 of occurrence of return to power.

10 MEMBER DIMITRIJEVIC: What's frequency of
11 occurrence because you want to consider all
12 challenges, right? I mean, you want to consider
13 beyond design basis event, too, right?

14 MR. SCHMIDT: Those will be addressed by
15 other people, but yes.

16 MEMBER DIMITRIJEVIC: So, you want to
17 consider all challenges and your end state is getting
18 back to power within 30 days which is also beyond PRA.
19 I mean, you know, we want to use the right features
20 put here, the PRA proves the risk for this type of
21 event is low or something like that.

22 CHAIR CORRADINI: But, I think, if I -- we
23 seem to have another staff member that's willing to
24 help us, but I think we're kind of coming back to
25 Pete's point which is, what do you compare it to?

1 But, low compared to what?

2 And, they're saying their probability --
3 their comparison point is at least within the lifetime
4 of the module. That's the comparison point for the
5 frequency.

6 MEMBER DIMITRIJEVIC: Lifetime of module
7 for what? Lifetime is the time, so that should be
8 frequency. I mean, this is not well defined.

9 MEMBER POWERS: You keep saying that, it
10 seems to be perfectly transparent.

11 MEMBER STETKAR: If you expect it to live
12 a 100 years, it would, to me, it would mean the
13 frequency is less than 1 in a 100 a year.

14 MEMBER BLEY: I'd like to get back to
15 where Pete and John were --

16 CHAIR CORRADINI: Can I get the staff
17 member who seems to want to volunteer information that
18 will get him in trouble? Mark, please identify
19 yourself.

20 MR. CARUSO: This is Mark Caruso from the
21 PRA and Severe Accident Branch in NRO.

22 And, I believe what they're talking about
23 is no more than the same thing as we've always had
24 some, you know, belief that LOCAs and locked rotors
25 were design basis accidents which were not expected to

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 occur within the life of the plant, some basis for it.

2 I think we're probably now, after some
3 years, some 30 years, we probably have a better idea
4 that they are in that category.

5 And, I think all they're saying is that
6 this is a new design basis accident. To get to this
7 condition, which would include you don't have power,
8 you can't borate, you've got -- you've gone down so
9 far in decay heat that you don't have the voids and
10 you have the moderator coefficient, all those
11 conditions exist for this event and it should have --
12 it should be an event whose likelihood is in the same
13 vein with LOCAs and any others.

14 And, it has acceptance criteria for
15 acceptance criteria.

16 Now, I will point out that one of the
17 parameters in LOCAs you're allowed to even have some
18 fuel damage, a few percent.

19 The criteria is being Part 100. Here,
20 we're saying -- I think they're saying, well, it's our
21 criteria is even more stringent. You don't need the
22 SAFDLs. That's DMB and whatever.

23 So, that accurate, Jeff?

24 MR. SCHMIDT: Yes, that's exactly
25 accurate.

1 I mean, I can't speak to the
2 probabilities, but I guess my feeling is the
3 probabilities will work out to an accident criteria
4 just like Mark pointed out.

5 And, we're using SAFDLs, which is an AOO
6 criteria which, again, is expected to happen in the
7 lifetime of the plant.

8 So, from that standpoint, the criteria
9 that the staff is proposing is conservative because,
10 again, if the probability works out to a locked rotor
11 or an accident like a LOCA, we allow fuel failure for
12 those.

13 CHAIR CORRADINI: I guess I forgot that,
14 that's a good reminder. Thank you.

15 MS. KARAS: This is Becky Karas. If I
16 could just also clarify.

17 CHAIR CORRADINI: Sure.

18 MS. KARAS: I just wanted to clarify on
19 the criterion and make sure everyone understands.

20 So, there are really two sets of criteria
21 for evaluating two different aspects on this slide.
22 Right?

23 So, the Chapter 15 is the design basis
24 sort of portion of the review.

25 The exemption criteria down here are

1 really a reflection of why would we consider this, and
2 as the SECY paper says, why would we consider this
3 departure from past precedent?

4 And so, it's used for meeting, you know,
5 the exemption criteria in the CFR that have to be
6 demonstrated, you know, at the special circumstances
7 and, you know, public health and safety and all of
8 that. Right?

9 So, that's where, you know, the
10 probability and the frequency of this event happening
11 are really factored in. In other words, you know,
12 that we would consider this specific to NuScale for
13 their design this type of, you know, exemption, you
14 know, provided, you know, they can show that that
15 probability is low.

16 So, that's the fact that we're looking at
17 it through that exemption request with those exemption
18 criteria is what makes that specific to this
19 circumstance for this reactor type.

20 CHAIR CORRADINI: Thank you, Becky.

21 MEMBER BLEY: Yes, I thought about -- I
22 hadn't thought about it quite this way before. But,
23 that last criteria, I'd like -- the frequency or
24 probability of occurrence is low. That makes sense to
25 me.

1 But, back to what I was talking about
2 before, we -- this -- in the PRA we'd say we want low
3 risk, low compared to other things.

4 Here, we're trying to make a hybrid of the
5 existing semi-qualitative, semi-quantitative approach
6 that we propose to use.

7 And, we had transients that happen all the
8 time. We have AOOs, we have to address them.

9 And then, and they happen within the life
10 of the life of the plant. And, typically, that's in
11 -- they say in a 100 years.

12 And then, we said things that are more
13 rare than that would be design basis events unless
14 they're extremely rare where they'd be beyond design
15 basis and you don't generally have to deal with them
16 unless some special thing has come up which has
17 happened several times.

18 And, that kind of makes of the order, the
19 accidents, the design basis accidents, things that
20 happen out of the order, 1 in a 1000 years, to 1 to
21 10,000 years kind of thing.

22 I'd be -- this says the probability of
23 occurrence ought to be low, not within the lifetime of
24 the module which is saying they ought to be a DBA.

25 And then, you'd think it ought to be

1 treated like the DBA which is what's been done so far.

2 I think it ought to be much less likely
3 than an DBA in which case it really does fall into
4 that beyond design basis and it fits in this framework
5 better.

6 So, I -- your parenthetical bothers me and
7 I think if it's at much less than the lifetime of the
8 facility is where I'd go. And, that means a factor of
9 100 to me.

10 Okay, this kind of gets yourself locked
11 around an axle in that that puts in a time frame of a
12 DBA and why wouldn't you treat it just like any other
13 DBA?

14 CHAIR CORRADINI: But, I don't -- I think
15 we're discussing rather than asking a question. So,
16 I want to make sure we get him to respond.

17 MR. SCHMIDT: Yes, so, we are treating
18 like a DBA. It's in Chapter 15, it's a DBA. What we
19 are -- and that's the first part of this slide was, we
20 consider this a design basis event with a likely
21 frequency of roughly an accident, postulated accident
22 but we are using the success criterial of an AOO which
23 is expected to happen in the lifetime of the plant.

24 And, hence, the staff is saying that since
25 we're using a SAFDL type criteria, GDC 10, that that

NEAL R. GROSS

COURT REPORTERS AND TRANSCRIBERS
1323 RHODE ISLAND AVE., N.W.
WASHINGTON, D.C. 20005-3701

1 is conservative and appropriate.

2 CHAIR CORRADINI: This truly -- I mean, my
3 --

4 MEMBER BLEY: I think it would be safe in
5 my interpretation of it, it's safe.

6 CHAIR CORRADINI: Any other questions?
7 We're cutting in and I want to make sure we give ample
8 time for public comment. Questions for Jeff?

9 (NO RESPONSE)

10 CHAIR CORRADINI: Okay. I think there's
11 nobody in the room, so we're going to skip right to
12 public comment on the phone line.

13 So, are -- is anybody on the phone line
14 that wants to make a public -- a comment about the
15 topic at hand?

16 MR. BROWN: Bridge open.

17 CHAIR CORRADINI: Thank you.

18 Anybody on the line?

19 (NO RESPONSE)

20 CHAIR CORRADINI: Hearing none, why don't
21 we close the bridge line?

22 Okay, any other questions for Jeff? I
23 think we've covered that.

24 Let me remind the Committee how we're
25 going to try this relative to discussion. I've

1 already sent out a week ago key points that I would
2 cover in a letter.

3 I got some comments back by some of the
4 members and I modified the key points which I am going
5 to show the key points when we start our discussion
6 for a letter. And, I drafted a letter based on the
7 key points.

8 So, we'll probably take that up after
9 lunch.

10 I also, I'm being a little bit
11 prescriptive, we can have as much discussion as you
12 want. I've scheduled five wonderful hours this
13 afternoon to talk over this if we want to hash it out.

14 Because I do know there are strong
15 opinions across the board here and I think we've got
16 to make sure they're appropriately discussed.

17 So, I'll show the key points that we had
18 gotten about a week ago, we can discuss that. And, I
19 have a draft letter which I wanted to pass out based
20 on that at least to start the ball rolling.

21 And, I -- you also got some comments by
22 individual members that had some pretty comprehensive
23 comments to make, the members did.

24 Yes? Okay.

25 Thank you very much. We'll take a break.

1 And, we come back, I think according to schedule, we
2 come back at 10:45 for the research review.

3 (Whereupon, the above-entitled matter went
4 off the record at 10:25 p.m.)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

NuScale Exemption Request to General Design Criterion 27

By

Jeff Schmidt – Senior Reactor Engineer, NRO/DSRA/SRSB

February 8, 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)

What is the Exemption?

- The exemption is from the staff's position that "reliably controlling reactivity changes" in GDC 27 includes the requirement to achieve subcriticality beyond the short term using only safety related equipment following a postulated accident with a stuck rod
- "Beyond the short term" means the long term, natural equilibrium state achieved by the reactor

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”

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 evaluating the SAFDLs (GDC 10) as the acceptance criterion to demonstrate adequate cooling by maintaining the fuel clad 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

February 1, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Submittal of Presentation Materials Entitled "Shutdown Capability of the NuScale Power Module," PM-0218-58480, Revision 0

REFERENCES: "NuScale Power, LLC Submittal of the NuScale Standard Plant Design Certification Application," dated December 31, 2016 (ML17013A229)

NuScale Power, LLC (NuScale) will meet with the Advisory Committee on Reactor Safeguards on February 8, 2018 to discuss its exemption request from General Design Criteria (GDC) 27.

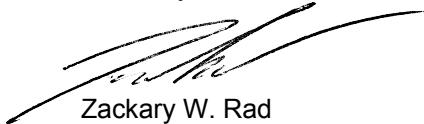
The purpose of this submittal is to provide presentation materials that NuScale intends to use at the meeting.

Enclosure 1 is the nonproprietary presentation entitled "Shutdown Capability of the NuScale Power Module," PM-0218-58480, Revision 0.

This letter makes no regulatory commitments or revisions to any existing regulatory commitments.

Please feel free to contact Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com if you have any questions.

Sincerely,



Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Frank Akstulewicz, NRC, OWFN-8H4A
Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A Rani
Franovich, NRC, OWFN-8G9A
Michael Snodderly, TWFN 2E26

Enclosure: "Shutdown Capability of the NuScale Power Module," PM-0218-58480, Revision 0



LO-0218-58493

Enclosure: "Shutdown Capability of the NuScale Power Module," PM-0218-58480, Revision 0

Shutdown Capability of the NuScale Power Module



Derick Botha
Darrell Gardner

February 8, 2018

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

- GDC 27 Exemption
- NuScale Reactivity Control Systems
- Exemption Review Criteria
- Design Evaluation
- Summary

GDC 27 Exemption

- NuScale has identified the possibility of a return to power condition under very limited conditions and assumptions
 - Passive cooldown to low RCS temperatures is unique to NuScale design
- This condition was evaluated against the General Design Criterion
 - NuScale did not identify a need for an exemption and believes current design satisfies the GDC
 - Draft GDCs explicitly required systems to make core “subcritical”
 - Final GDCs revised by the Commission to address “controlling reactivity changes” to assure acceptable radiological consequences
 - NuScale design approach is consistent with literal language and intent of final GDCs
 - NuScale submitted a white paper on reactivity control (LO-1116-51829, Nov 2016) and addressed compliance with GDC 26 and 27 reactivity control functions
 - protection function: rapid power reduction to protect fuel, assuming WRSO, to protect fuel (AOOs under GDC 26) or to maintain core cooling capability to mitigate the consequences of accidents (DBAs under GDC 27)
 - shutdown function: capability to hold the core subcritical under cold conditions

GDC 27 Exemption

- NRC staff position (ML16116A083, Sep 2016) is that an exemption from GDC 27 is required
 - design departs from precedent (i.e., long-term shutdown with WRSO)
- NuScale complied with staff position and applied for exemption to GDC 27
 - whether or not an exemption is required, NuScale believes the design solution and safety demonstration are unchanged
- Exemption and FSAR establish PDC 27
 - Regulations require NuScale to define the PDCs for the design, and relation of the design bases to the PDCs
 - PDC 27 addresses precedent by explicitly defining requirement for long-term shutdown following postulated accident: NuScale design assures long-term shutdown with all rods in, but recriticality with WRSO would not exceed CHF:
 - *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 Reactivity Control Systems

- NuScale uses two primary reactivity control systems
 - safety-related control rods and nonsafety-related chemical volume and control system (CVCS)
- The selected reactivity control systems are consistent with NuScale design objectives for passive safety and simplicity
 - design does not use ECCS makeup with boron - typically the only safety-related boron injection for PWRs
 - Following transients, RCS passively cools down to low temperatures – not just to “hot shutdown”
 - Control rods alone maintain shutdown through entire RCS temperature range
- Assuming certain low probability conditions, there is a possibility of a return to power after a trip concurrent with a control rod malfunction (stuck rod)
 - late in core life (low boron concentration) and at low decay heat (core has cooled significantly), the small core with high control rod worth could experience a return to power if the highest worth rod is stuck out and AC power is not available to operate the active CVCS system
 - in all cases, reactor immediately shuts down after a trip using only control rods, even with WRSO
 - 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* (negative reactivity feedback from voiding in the core limits return to power)

Exemption Review Criteria

- NuScale believes maintaining core cooling is the design objective of reactivity control systems in GDC 27 (postulated accidents)
 - the “safety concern” for a return to power event is that it could challenge heat removal system capability such that the core is insufficiently cooled resulting in core damage
 - maintaining peak cladding temperature limits is considered sufficient to maintain core cooling
 - core cooling is conservatively demonstrated by maintaining CHF limits
- NRC’s proposed criteria for an exemption to GDC 27 is conservative
 - maintain AOO acceptance criteria (CHF) and restrict frequency to less than that of an AOO (not expected in the life of a module)

Design Evaluation

	Deterministic Evaluation (Chapter 15)	Probabilistic Evaluation
Purpose	Evaluate safety	Evaluate shutdown reliability
Conservative assumptions	<ol style="list-style-type: none"> 1. WRSO with limiting shutdown margin 2. MTC 3. Cooldown rate 4. Xenon and boron concentration 5. No credit for non-safety systems 	<ol style="list-style-type: none"> 1. CVCS failure on demand vs. less likely extended unavailability of CVCS and CFDS 2. Occurs throughout cycle vs. latter 30% of cycle 3. No decay heat after restart vs. more likely decay heat levels to prevent return to power
Probability	=1 under Ch 15 assumptions =0 that all assumptions will actually occur	<1E-6 per reactor module year
Event progression	<ol style="list-style-type: none"> 1. Return to power at 2+ hrs with DHRS cooldown 2. ECCS actuates resulting in subcriticality <ul style="list-style-type: none"> - in less than 24 hours if AC and DC power is lost, or - after 24 hours with DC power available 3. Limiting condition for ECCS heat removal and CHF is subcriticality with maximum decay heat 	<ol style="list-style-type: none"> 1. Return to power during DHRS cooldown is prevented 2. Without AC power, ECCS actuates after 24 hours 3. Remains shut down until decay heat reduces to < 100 kW 4. Sufficient time to restore function to CVCS or CFDS to prevent a return to power
Criteria	CHF limit not exceeded	Not expected to occur during the life of a module

Design Evaluation

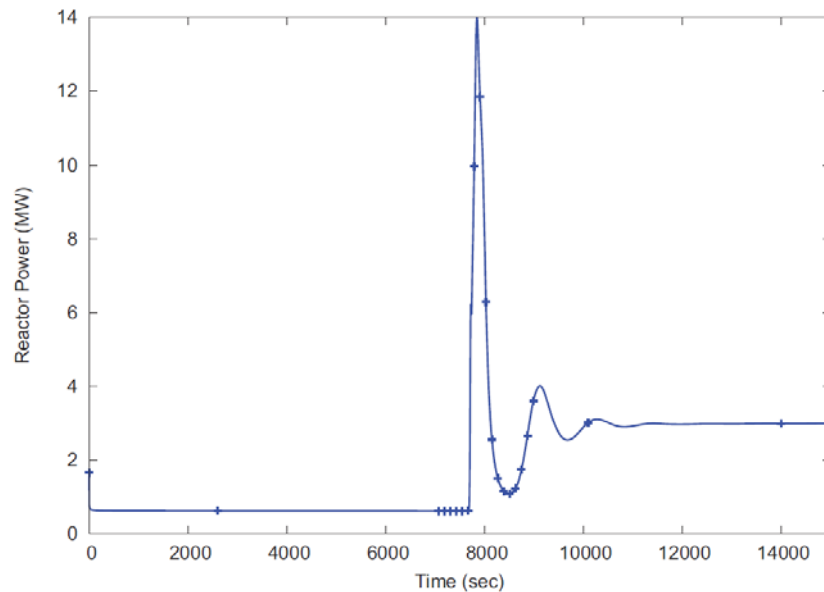
- The capacity of the NuScale passive heat removal systems (DHRS, ECCS) are sufficiently sized to ensure the core remains cooled, irrespective of control rod performance
 - core is protected after a return to power with a WRSO, or even after a failure to trip the reactor (ATWS)
- NuScale safely controls reactivity through natural, predictable, and reliable phenomena (negative void and reactivity feedback)
 - using additional systems to increase shutdown reliability will increase design complexity, reduce overall reliability and likely safety
 - licensed designs had to ensure subcriticality, using deterministic assumptions including a WRSO, to maintain core cooling (limit heat production within the capacity of decay heat removal systems).
 - DHRS heat removal characteristic in combination with negative moderator coefficient leads to self-limiting condition
 - higher power -> higher moderator temperature -> negative moderator feedback
 - 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

Summary

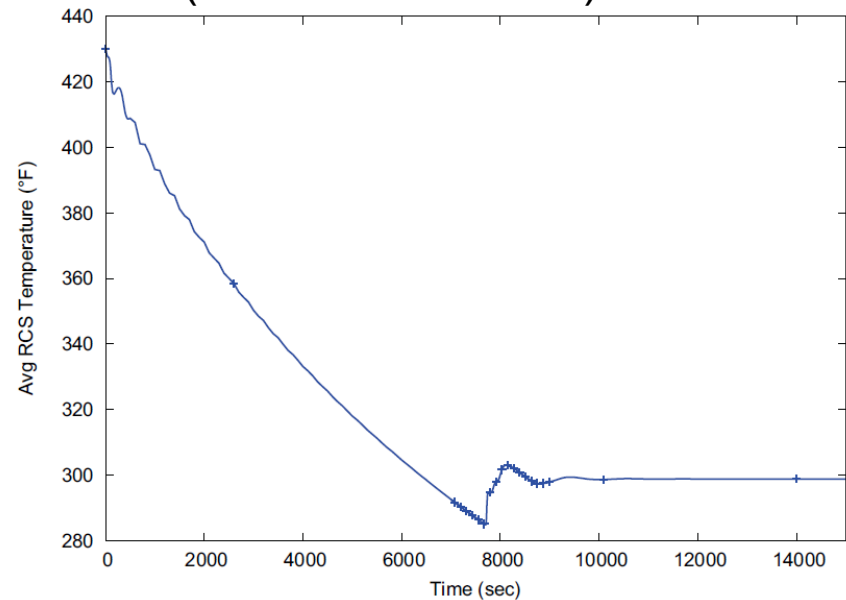
- NuScale is pursuing an exemption from GDC 27 consistent with NRC staff position
- Reactivity control systems are consistent with design objectives for simplicity and passive safety and provide
 - rapid shutdown to protect fuel
 - reliable capability to maintain subcriticality under cold conditions
 - passive heat removal that protects against control rod malfunctions
 - alignment 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 low probability event with no radiological consequences

Backup Slides

Reactor Power (Peak Power Case, EDSS Available)

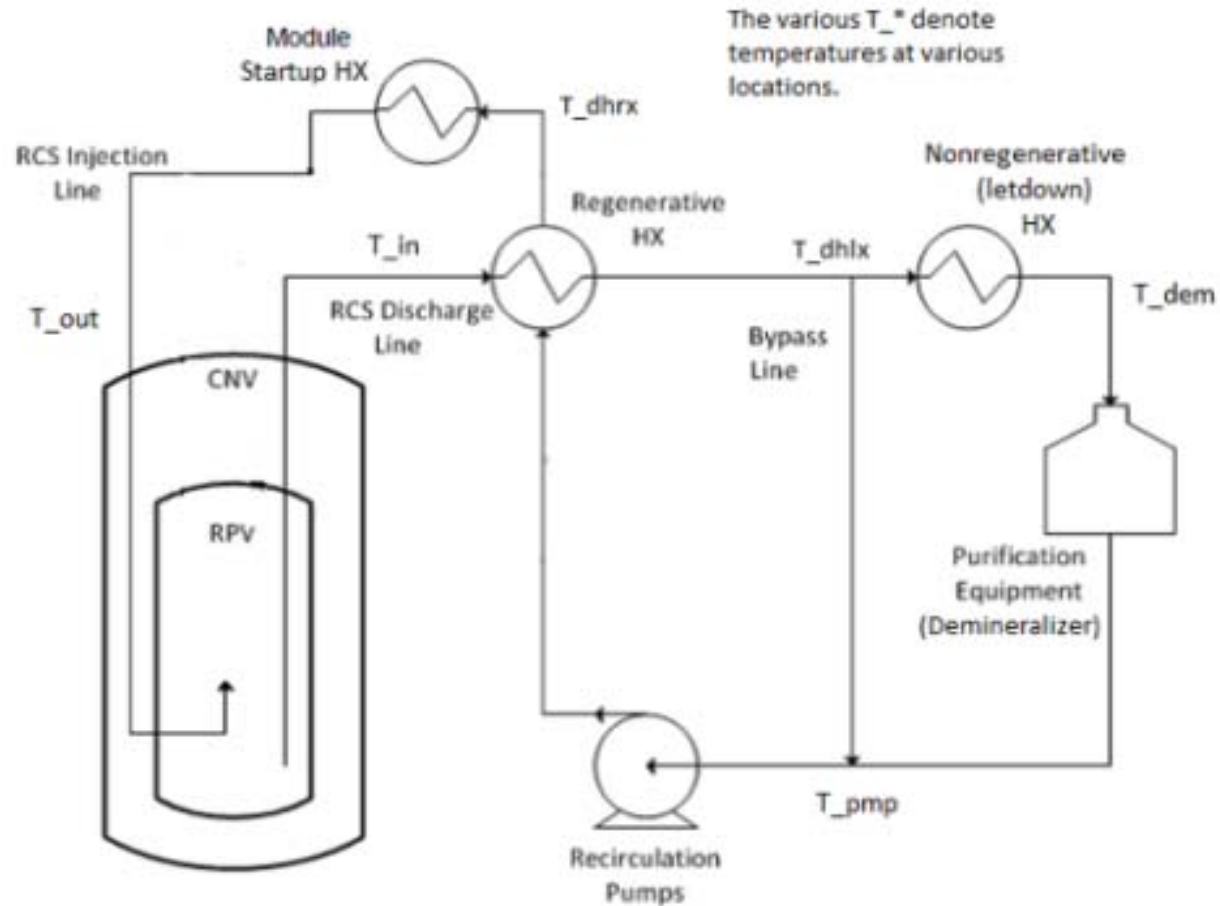


RCS Average Temperature (Peak Power Case)



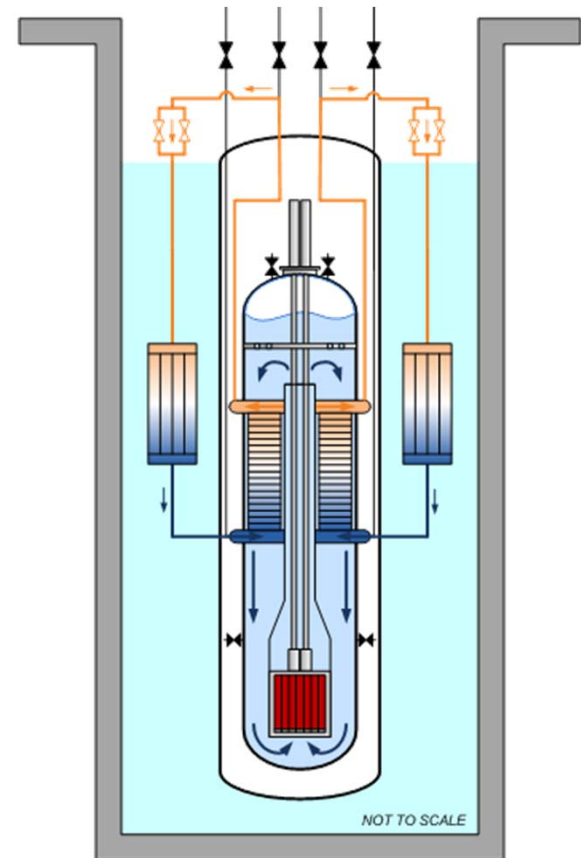
Backup Slides

Simplified CVCS Diagram



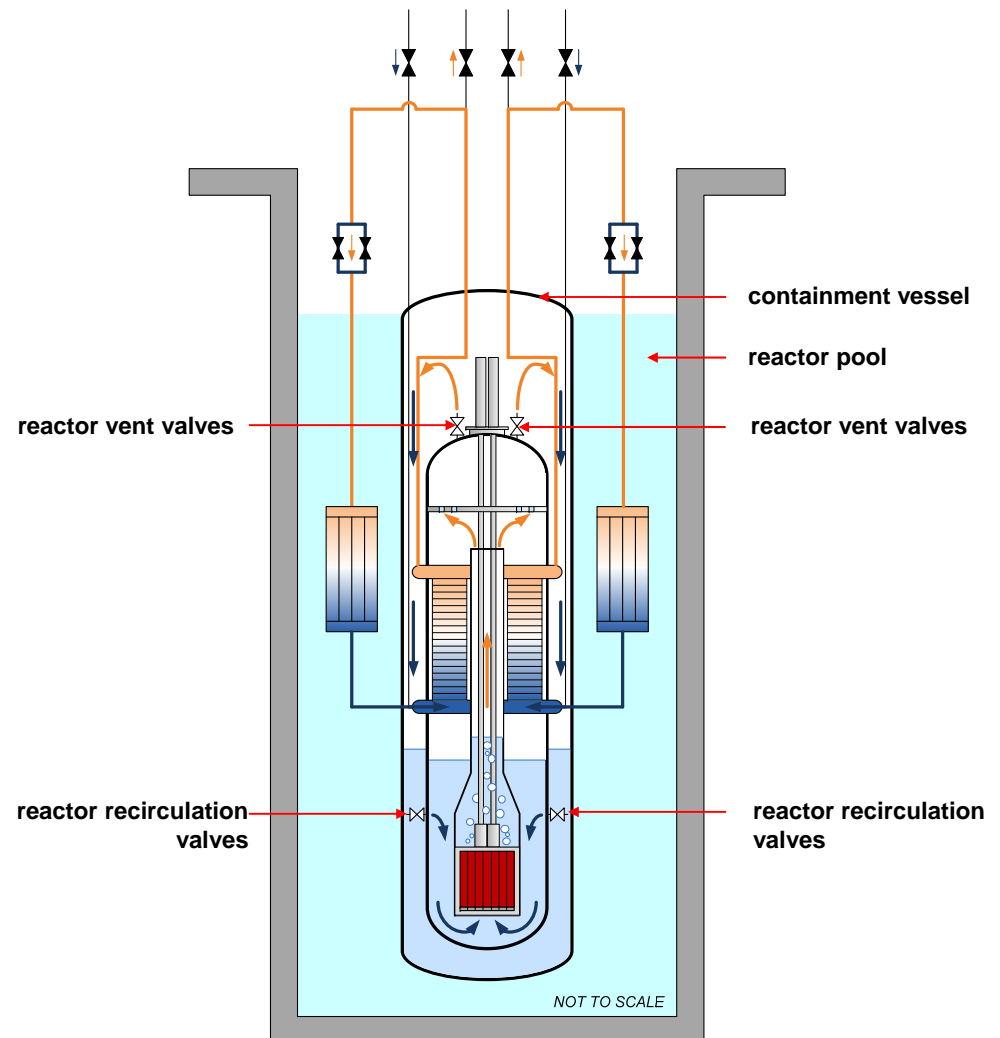
Design Overview: Passive Decay Heat Removal System

- 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





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

6060 Piedmont Row Drive South, Suite 600
Charlotte, NC 28287
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>
Twitter: @NuScale_Power

