

**Official Transcript of Proceedings**

**NUCLEAR REGULATORY COMMISSION**

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                          NuScale Subcommittee: Open Session

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13 Commission Advisory Committee on Reactor Safeguards,  
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2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 + + + + +

7 NUSCALE SUBCOMMITTEE

8 + + + + +

9 OPEN SESSION

10 + + + + +

11 TUESDAY

12 FEBRUARY 4, 2020

13 + + + + +

14 ROCKVILLE, MARYLAND

15 + + + + +

16 The Subcommittee met at the Nuclear  
17 Regulatory Commission, Two White Flint North, Room  
18 T2D30, 11545 Rockville Pike, at 8:30 a.m., Walt  
19 Kirchner, Chair, presiding.

20

21 COMMITTEE MEMBERS:

22 WALTER L. KIRCHNER, Chair

23 RONALD G. BALLINGER, Member

24 DENNIS BLEY, Member

25 CHARLES H. BROWN, JR., Member

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1 VESNA B. DIMITRIJEVIC, Member  
2 JOSE MARCH-LEUBA, Member  
3 DAVID A. PETTI, Member  
4 JOY REMPE, Member  
5 PETER RICCARDELLA, Member  
6 MATT SUNSERI, Member

7  
8 ACRS CONSULTANT:

9 STEPHEN SCHULTZ  
10  
11 DESIGNATED FEDERAL OFFICIAL:

12 MICHAEL SNODDERLY  
13  
14 ALSO PRESENT:

15 BRUCE BAVOL, NRR  
16 SARAH BRISTOL, NuScale\*  
17 MARTY BRYAN, NuScale  
18 LARRY BURKHART, NRR  
19 MARK CHITTY, NuScale\*  
20 JEFF EHLERS, NuScale  
21 SARAH FIELDS, Public Participant\*  
22 STEVE HAMBRIC, Consultant\*  
23 JOHN HONCHARIK, NRR\*  
24 PAUL INFANGER, NuScale  
25 ATA ISTAR, NRR

1 DAN LASSINGER, NuScale  
2 GREGORY MAKAR, NRR  
3 SCOTT MOORE, Executive Director, ACRS  
4 TONY NAKANISHI, NRR  
5 JOSH PARKER, NuScale  
6 REBECCA PATTON, NRR  
7 SHEILA RAY, NRR  
8 JOE REMIC, NuScale  
9 SUJIT SAMADDAR, NRR  
10 THOMAS SCARBROUGH, NRR  
11 JEFF SCHMIDT, NRR  
12 KEVIN SPENCER, NuScale  
13 OMID TABATABAI, NRR  
14 CARL THURSTON, NRR  
15 KENT WELTER, NuScale  
16 BRIAN WOLF, NuScale  
17 YUKEN WONG, NRR  
18 BRADEN WUTH, NuScale  
19 PETER YARSKY, RES  
20  
21  
22 \*Present via telephone  
23  
24  
25

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## 1 P R O C E E D I N G S

2 8:31 a.m.

3 CO-CHAIR KIRCHNER: Okay. Good morning.

4 This meeting will now come to order. Let me start one  
5 more time. Okay. This meeting will now come to  
6 order. This is a meeting of the Advisory Committee on  
7 Reactor Safeguards, NuScale Subcommittee.

8 I am Walt Kirchner, Chairman of the  
9 subcommittee. Member Ron Ballinger will co-chair this  
10 morning's session. Members in attendance today are  
11 Ron Ballinger, David Petti, Peter Riccardella, Joy  
12 Rempe, Matt Sunseri, Jose March-Leuba, Charlie Brown  
13 will be with us in an hour, Dennis Bley, and Vesna  
14 Dimitrijevic.

15 We also are joined by our consultant,  
16 Stephen Schultz. And I think on the line we will have  
17 Mike Corradini as well, a consultant.

18 Mike Snodderly is the designated federal  
19 official for this meeting. The subcommittee will  
20 conduct an area focus review on the NuScale steam  
21 generator design, turbine missile analysis,  
22 inadvertent actuation block valve, and electrical  
23 system reliability.

24 Today we have members of the NRC staff and  
25 NuScale to brief that --

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5 MEMBER MARCH-LEUBA: They don't hear us.

6 CO-CHAIR KIRCHNER: They mustn't hear us.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. The NRC implements FACA in accordance with its regulations found in Title 10 of the Code of Federal Regulations, Part 7.

12                   The committee can only speak through its  
13 published letter reports. We hold meetings to gather  
14 information and perform preparatory work that will  
15 support our deliberations at a full committee meeting.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, agendas, letter reports, and full transcripts of all full and subcommittee meetings, including slides presented there. The meeting notice and agenda for this meeting were posted there.

25 Portions of this meeting can be closed as

1         needed to protect proprietary information pursuant to  
2         5 USC 552(b)(c)(4).

3                 As stated in the Federal Register notice  
4         and in public meeting notice posted to the website,  
5         the members of the public who desire to provide  
6         written or oral input to this subcommittee may do so  
7         and should contact the designated federal official  
8         five days prior to the meeting, as practicable.

9                 We also have set aside ten minutes for  
10        comments from members of the public attending or  
11        listening to our meetings. Yeah, NuScale probably in  
12        Corvallis cannot hear us. But if one of you could  
13        text them, just have them mute their phones so they're  
14        not broadcasting.

15                 PARTICIPANT: They are. I did do that --

16                 CO-CHAIR KIRCHNER: Okay. Thank you.

17                 We have not received written comments or  
18        requests for time to make oral statements for the  
19        members of the public regarding today's meeting.

20                 A transcript of the meeting is being kept  
21        and will be made available on the ACRS section of the  
22        U.S. NRC public website.

23                 We request that participants in this  
24        meeting please use the microphones located throughout  
25        the meeting room when addressing the subcommittee.

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1 Participants should first identify themselves and  
2 speak with enough volume and clarity so that they can  
3 be readily heard.

4 A telephone bridge line, as we've noticed,  
5 has been established for the public to listen to the  
6 meeting. To minimize disturbance, the public line  
7 will be kept in a listen-in-only mode.

8 To avoid other disturbances, I request  
9 that attendees put their electronic devices, such as  
10 cell phones, in the off or noise-free mode.

11 We'll now proceed with the meeting. I  
12 will look first to Ron for this morning's session. We  
13 have a full day today. This morning is given over for  
14 the steam generator discussions. Ron, have you any  
15 further comments?

16 MEMBER BALLINGER: Not really, no.

17 CO-CHAIR KIRCHNER: Okay. So, with that,  
18 I'm going to turn to the NuScale people. Thank you.  
19 Marty, are you going to kick it off?

20 MR. BRYAN: Yes.

21 CO-CHAIR KIRCHNER: Please.

22 MR. BRYAN: Yes, I'm Marty Bryan, the  
23 NuScale licensing project manager for Chapter 3. And  
24 in the open session today, we're going to cover steam  
25 generator design, the steam generator inspection

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1 program. We're going to talk a little bit about  
2 density-wave oscillation, and then the ITAAC closure  
3 path for density-wave oscillation or DWO, then some  
4 results from our preliminary scope of study, and then  
5 plant closure activities through ITAAC.

6 So, with me this morning, I have a number  
7 of gentlemen. So, right now, I'll turn it over to  
8 Kevin Spencer. And he's going to take us through the  
9 first part of this.

10 MR. SPENCER: Hi. Good morning. I'm  
11 Kevin Spencer. And I'll be speaking a little bit this  
12 morning about steam generator design.

13 So the NuScale steam generator is designed  
14 to be an integral helical coil steam generator. The  
15 primary side fluid is on the shell side of the steam  
16 generator. And the secondary fluid is inside the  
17 tubes.

18 The two bundles are made out of Alloy 690  
19 thermally treated. There are about 1,380 tubes. They  
20 range in length from 77 to 87 feet long. And we have  
21 a 5/8-inch outer diameter of the tubes.

22 Because of natural circulation on the  
23 primary side, we have very low velocities,  
24 approximately one foot per second on the outer  
25 diameter of the tube.

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1                   Within the tube sizing, we have included  
2 a ten mils allowance for corrosion and erosion or  
3 erosion degradation. Alloy 690 thermally treated --

4                   CO-CHAIR KIRCHNER: May I ask anyone on  
5 the phone lines to mute their phones? We are getting  
6 interference with the speakers here in Washington.  
7 Thank you.

8                   MR. SPENCER: Thank you. As I was saying,  
9 there is, in the tube wall sizing, a 10 mils allowance  
10 for corrosion/erosion. Of course, Alloy 690 thermally  
11 treated material is very corrosion and erosion  
12 resistant. Nevertheless, we include some additional  
13 wall thickness above the ASME min wall requirement to  
14 cover the corrosion/erosion throughout the life of the  
15 plant.

16                   The tube design will support 100 percent  
17 volumetric inspection of the tubes. So every tube  
18 will be able to be volumetrically inspected during  
19 outages.

20                   And, additionally, because of the design  
21 during refueling, when the NuScale power module  
22 actually separates into multiple segments, we will  
23 have access to the shell side of the tubes from below  
24 the bundle during refueling. This will assist with  
25 any evaluations on the shell side degradation, as well

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1       as any foreign material or other inspections that need  
2       to happen on the outer diameter of the tubes.

3                    MEMBER BALLINGER: I'm not sure whether  
4       this is a proprietary question or not or whether this  
5       is the right time to ask it. But you say there's a  
6       .01-inch allowance for corrosion and erosion. You  
7       know, Alloy 690 is really not susceptible to cracking.

8                    MR. SPENCER: Right.

9                    MEMBER BALLINGER: But its Achilles heel  
10      is wear. And in fact, it's about five times higher  
11      than Alloy 600, round numbers.

12                  And so, if you, at some point, couple that  
13      with potential instabilities where the vibrations and  
14      things like that can really get going, is that enough?

15                  MR. SPENCER: Well --

16                  MEMBER BALLINGER: Have you looked, have  
17      you really looked at the issue of wear with respect to  
18      the overall design and operation?

19                  MR. SPENCER: Yes. We will be speaking a  
20      little bit to wear during, a little bit later in our  
21      presentation. As far as wear due to DWO, you know,  
22      most of the oscillations during DWO are considered to  
23      be thermal stresses.

24                  So, other than, you know, maybe some wear  
25      due to axial growth of the tube and wear of the tube

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1 along the supports, which we will address a little bit  
2 later, we don't expect to have any sort of, you know,  
3 high velocity. We don't expect to have any high  
4 velocity flows in the tubes.

5 The primary fluid around the tube is very  
6 slow. The secondary fluid on the inside of the tube  
7 is well within kind of nominal or -- that we don't  
8 expect to have high velocity secondary flows either.

9 MEMBER BALLINGER: Yeah, I understand  
10 that. But the wear issue is coupled, is more  
11 dependent on relative movement --

12 MR. SPENCER: Right.

13 MEMBER BALLINGER: -- for things like  
14 that. And that's independent of some of that --

15 MR. SPENCER: Right. Wear due to fretting  
16 at the supports --

17 MEMBER BALLINGER: Yeah.

18 MR. SPENCER: -- would be a concern that  
19 we will address.

20 MEMBER BALLINGER: Okay.

21 MR. SPENCER: I guess at this point, I'll  
22 just jump to the next slide real quick, even though we  
23 haven't quite finished with this one.

24 MEMBER MARCH-LEUBA: Are you going to come  
25 back to this one?

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1                   MR. SPENCER: I'll come back to this one,  
2 yeah --

3                   MEMBER MARCH-LEUBA: Okay.

4                   MR. SPENCER: -- and cover the points.  
5 But I'll just going through --

6                   MEMBER MARCH-LEUBA: Well, while you have  
7 it there, you think incorporation of operating  
8 experience, almost every coal fired plant in the world  
9 uses a helical steam generator, right.

10                  How does this one differ from the existing  
11 ones, I mean, the ones where we have a lot of  
12 experience with, the coal fired plants? Is there  
13 anything special about NuScale steam generator that  
14 makes it different?

15                  MR. SPENCER: I can't speak too much to  
16 coal, coal fired designs. I guess in terms of, you  
17 know, previous PWR experience, you know, normally we  
18 would have a u-tube recirculating steam generator,  
19 that's very common, or a one-screw steam generator,  
20 which tends to be stray axial tubes.

21                  MEMBER MARCH-LEUBA: But in the PWRs, the  
22 steam is on the shell side.

23                  MR. SPENCER: I don't think on, I wouldn't  
24 imagine in the coal plants they would use Alloy 690,  
25 but maybe they do.

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1                   PARTICIPANT: That is the difference.

2                   MR. SPENCER: Yeah.

3                   MEMBER RICCARDELLA: As well, also I think  
4                   the diameter of the tubes is significantly different  
5                   in coal. Coal plants are, you know, much bigger.

6                   MEMBER MARCH-LEUBA: Yeah --

7                   MEMBER RICCARDELLA: Yeah.

8                   MEMBER MARCH-LEUBA: There is a lot of  
9                   experience. There are thousands of those steam  
10                  generators working in the field. And we should have  
11                  gained some experience from them. I mean, from what  
12                  we should use, what do you know?

13                  MEMBER BALLINGER: Yeah, you recognize  
14                  that our concern is the fact that minor changes in  
15                  dimensions and design at San Onofre caused a lot of  
16                  wear issues.

17                  And it's kind of a threshold phenomena  
18                  when you come right down to it. Nobody expected that  
19                  it would exist. And so you're very different in that  
20                  respect.

21                  MR. SPENCER: Right. To be fair, that was  
22                  a flow-induced vibration, though. And we don't have  
23                  the same, you know, we don't have the same fluid  
24                  velocities that they were experiencing. But I do  
25                  understand your comment there.

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1 MEMBER BALLINGER: But the source of the  
2 vibrations are different.

3 MR. SPENCER: Right.

4 MEMBER BALLINGER: But you might have some  
5 conditions which --

6 MR. SPENCER: Right.

7 MEMBER BALLINGER: -- result in vibrations  
8 which --

9 MR. SPENCER: It increased wear --

10 MEMBER BALLINGER: -- increased wear.

11 MR. SPENCER: Yep. So, to the next slide,  
12 I'll just go through a little bit about the actual  
13 steam generator design here pictorially.

14 On the left side of the slide, you can see  
15 the helical coil steam generator. It's kind of color-  
16 coded here.

17 Now, each NuScale power module will  
18 include two independent steam generators. Each steam  
19 generator has its own steam isolation valve. And they  
20 are completely independent. They have an independent  
21 feedwater train, independent steam plenum, et cetera.

22 The way that these are linked here, you'll  
23 see at the bottom, there are three colors. There's a  
24 red, a blue, and a yellow. And then behind and not  
25 pictured in this would be the green coil. The blue

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1 and the green coils are the same steam generator. And  
2 the red and the yellow are the same steam generator.

3 As each -- at the bottom is the feedwater  
4 plenum. So that's where the feedwater is introduced.

5 There are 21 columns of tubes. Each tube  
6 column alternates in the direction of the helical  
7 coil. So they go counterclockwise. And then the next  
8 row, the next column would go clockwise.

9 You'll notice at the top of the bundle  
10 where we have four steam plenums, you'll notice that  
11 while the red, the yellow, and the blue and the green  
12 are still segregated into two different steam  
13 generator common plenums, you'll notice that the tubes  
14 themselves are intermixed. This is to keep the --

15 So sometimes the steam generator requires  
16 an additional half coil or the subtraction of a half  
17 coil in order to remain, that that column remains in  
18 the overall same length range as the other columns.

19 Also here in the middle and at the, on the  
20 right here we show a little bit about our steam  
21 generator support system. Our support system is  
22 accomplished by the steam generator support plates.  
23 On the bottom middle inset here, you'll see the steam  
24 generator tubes and their interaction with the steam  
25 generator support plate.

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1                   The steam generator support plate has  
2 three tabs of support for each tube. Then there is  
3 common tabs between the tubes. Those tabs are bent  
4 out from the plate material. And they provide a  
5 three-point support method for the tube as it curls  
6 through and contacts the plate.

7                   In addition, those plates are sandwiched  
8 together, which you can kind of see in the upper  
9 middle side view of the drawing there, where two  
10 plates and their associated tabs will be sandwiched  
11 together and in contact to prevent the tubes from  
12 moving back and forth or to constrain their growth  
13 related to the axis of the helical coil.

14                  The steam generator support plates are  
15 held in place by the support assembly that you see on  
16 the right. There's an upper plate, or there's an  
17 upper t-bar that will be used to hang the plates. And  
18 there's a lower steam generator support, which will  
19 keep them aligned.

20                  And then the plates are free to move in  
21 the radial direction with respect to the ax helical  
22 coil. This allows this -- thermal expansion and  
23 growth during heat-up and cool-down.

24                  MEMBER RICCARDELLA: Would you give a  
25 little more detail? You said three-point support. I

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1       don't quite understand how the tab provides three-  
2       point support.

3                    MR. SPENCER: So there are three tabs. So  
4       there's going to be, there's -- one tab is either  
5       going to be on the top or the bottom of the tube and  
6       then two tabs on the remaining side.

7                    MEMBER MARCH-LEUBA: Marty, you can use  
8       the mouse to point to the tabs. Is that what you're  
9       trying to do?

10                  MR. SPENCER: So down in the lower  
11      picture, Marty, on the left-hand side where the yellow  
12      and green bundle are, you can see there that we have  
13      on -- the top tube is held by those two top tabs and  
14      then one tab on the bottom.

15                  MEMBER RICCARDELLA: Got it.

16                  MR. SPENCER: And the next tube on the,  
17      below it is held by that, the bottom side of that  
18      upper tab, and then two other tabs.

19                  MEMBER RICCARDELLA: Thank you.

20                  MR. SPENCER: Any other questions about  
21      the steam generator design? Okay.

22                  So back to the previous slide, Marty.  
23      I'll talk about incorporation of operating experience.  
24      So we did follow the guidance of NEI 97-06 and EPRI,  
25      the COL Item 5.4-1, which is to develop and implement

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1           a steam generator program.

2                         With regards to operating experience, you  
3 know, we want to determine what's applicable and not  
4 applicable. But we also want to see what operating  
5 experience might apply with modifications and any  
6 deltas that we may see to any operating experience,  
7 any differences and any additional information or any  
8 ways in which our tube bundle would be different than  
9 previous operating experience.

10                  MEMBER MARCH-LEUBA: But based on your  
11 previous, I'm sorry, you did not incorporate any coal  
12 fired plant operating experience because those are  
13 more applicable to yours.

14                  MR. SPENCER: I can't speak to, I can't  
15 answer that question myself. We could look into  
16 whether --

17                  MEMBER MARCH-LEUBA: There's --

18                  MR. SPENCER: -- there was operating  
19 experience from coal fired plants.

20                  MEMBER MARCH-LEUBA: You'll send an email  
21 to Mike --

22                  MR. SPENCER: Yeah.

23                  MEMBER MARCH-LEUBA: -- whether you --  
24 most steam generators in the nuclear industry have the  
25 steam on the shell side, where is --

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1                   MR. SPENCER: Right, right.

2                   MEMBER MARCH-LEUBA: Coal fired plants  
3 have it in the inside. And they manage to run them  
4 very well. You need to figure out what's their  
5 secret.

6                   MR. BRYAN: Yeah, I think the plan is to  
7 look at the relevant experience. And so we'll get  
8 back with you on that answer.

9                   CO-CHAIR KIRCHNER: Just for the record,  
10 Fort St. Vrain had helical steam generators like this.  
11 Of course, that was helium cooled system. But there  
12 is some operating experience that's relevant.

13                  MR. WELTER: Hi, this is Kent Welter. So  
14 I can make a -- we'll look on the question regarding  
15 the coal fired plant. I know from looking at  
16 modeling, and we'll talk about that more in the closed  
17 session, from thermal-hydraulics, we definitely looked  
18 at a wide range of literature for thermal-hydraulics  
19 modeling.

20                  From a, I would say from a wear  
21 perspective, an operational perspective, we've also  
22 taken a look at the Otto Hahn reactor, which is a  
23 ship-based reactor. There are older reports. But  
24 there's a number of reports affirming what's a  
25 degradation, what's destructive and non-destruction of

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1 testing.

2                   So we get a lot of information from, or  
3 insights from the Otto Hahn reactor, which actually  
4 has a very similar steam generator plenum and stepped-  
5 orifice design that the NuScale has.

6                   And it's not the exact conditions. It's  
7 a little bit lower pressure, a little bit lower  
8 temperature. But that reactor is quite similar to  
9 ours. And so we are looking at using some of that  
10 experience --

11                  MEMBER MARCH-LEUBA: Maybe you are  
12 expecting me to ask the question. That reactor, was  
13 it stable?

14                  MR. WELTER: What's that?

15                  MEMBER MARCH-LEUBA: Was that reactor  
16 stable?

17                  MR. WELTER: Yeah, and so that actually  
18 gave us a lot of information and lessons learned in  
19 terms of --

20                  MEMBER MARCH-LEUBA: So --

21                  MR. WELTER: And we can get maybe more of  
22 that in the closed session. But, yeah, that gives us  
23 a lot of lessons learned.

24                  MEMBER MARCH-LEUBA: Yeah, so everybody  
25 else wants us to make the steam generators stable. I

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1 think that is a fact of life.

2 MEMBER BALLINGER: But the Otto Hahn did  
3 not have 690.

4 MR. WELTER: In terms of a material  
5 perspective, yeah, you are correct, yeah.

6 And so what we did is we looked at -- you  
7 know, they have a number of, when you're looking at  
8 the non-destructive testing and look at the cracks  
9 that formed on the tube-to-tube sheet welds and  
10 looking at the number of cracks and the type of cracks  
11 and what the potential causes are, we can learn from  
12 that and take that into consideration in our design.

13 MR. SPENCER: So Kent did mention the flow  
14 restrictor design at Otto Hahn. And we do have a flow  
15 restrictor designed into our steam generator at the  
16 tube inlet.

17 It is a stepped loss, which produces a  
18 large inlet pressure drop due to the expansion and  
19 contraction of the fluid as it passes through the flow  
20 restrictor. This prevents and mitigates density-wave  
21 oscillations.

22 MEMBER MARCH-LEUBA: I need to step in  
23 here. The whole FSAR is full of the statements like  
24 this, which are very good aspirational goals. But  
25 they're completely unproven.

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I mean, you say the flow restrictor ensures acceptable criteria are satisfied. And when we get to the operator slides, you'll tell me that at least one of the criteria at least with the preliminary concern with the calculations is not satisfied.

7 So, I mean, you're contradicting yourself.  
8 And we'll talk about this on the classified, not  
9 classified, proprietary session. But the whole FSAR  
10 is full of statements like this, completely unproven  
11 and undocumented.

At best, you'll be able to prove the statement when you finish your ITAACs. But right now, you don't have a leg to -- I mean, you have -- it's a good aspirational goal. But it's not a statement.

21 MEMBER MARCH-LEUBA: But I'm going to  
22 recommend to the staff that they review their SCRs  
23 with respect to a statement like this and Chapter 5,  
24 which say don't bother with it, everything is good.  
25 And you have an honest mistake Okay.

1 CO-CHAIR KIRCHNER: Kevin, for the record,  
2 how big of a pressure drop are you taking there? Your  
3 nominal steam conditions are what? Our inlet  
4 feedwater pressure is what?

5 MR. SPENCER: I guess if we were to speak  
6 to actual data like that, I probably should hold off  
7 to the closed session.

8 MEMBER MARCH-LEUBA: It is on the open  
9 session of the FSAR. But let's hold on.

10 CO-CHAIR KIRCHNER: Okay --

11 (Simultaneous speaking.)

12 CO-CHAIR KIRCHNER: Yeah. Okay.

13 MR. SPENCER: So I'll go to two slides,  
14 Marty. So we are required to have a steam generator  
15 inspection program. The purpose of a steam generator  
16 inspection program is to monitor the performance and  
17 the condition of the steam generators during in-  
18 service inspections. It is required by the ASME,  
19 Section 11 of the ASME code, as well as 10 CFR  
20 50.55(a), bullet g.

21 We do have to implement the steam  
22 generator inspection program according -- and it needs  
23 to follow the NEI 97-06 and EPRI guidance regarding  
24 steam generator management programs. It must include  
25 a lot of different things, such as primary and

1 secondary water chemistry, evaluations and such.

2                   But particularly today, we would note that  
3 the steam generator inspection program will include  
4 degradation assessments. This will include wear due  
5 to fretting that may be caused by, or that may be  
6 attributed to density-wave oscillations, as well as  
7 other degradations that may occur by any sort of  
8 cracking or volumetric flaws that are discovered.

9                   There will be a tube integrity assessment.  
10 The tube integrity assessment will look at, it will be  
11 both backwards looking and forwards looking. So it  
12 will look at past wear and compare current wear to  
13 past wear, as well as it will look ahead for operation  
14 and look at wear rates to determine that, you know, to  
15 determine safe operation until the next inspection can  
16 be performed.

17                   MEMBER BALLINGER: Now, I would -- again,  
18 not to beat a dead horse, but 97.06 and the EPRI  
19 guidelines and all that are basically evolved  
20 historically based on u-tube steam generator design.

21                   And so the frequency of inspection is,  
22 would be different or might be, need to be different  
23 for this steam generator. So have you given thought  
24 to a pattern of inspection times so that you can  
25 validate things initially?

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1                   MR. SPENCER: Well, I think that we would  
2 still be in the planning stage of what we would  
3 recommend for the steam generator inspection program,  
4 which would be incorporated into the technical  
5 specification of the plant.

6                   But preliminary wear assessments that we  
7 have are probably going to be pretty, or preliminary  
8 wear assessments that we perform show that we have a  
9 lot, because we have a lot less wear due to other  
10 phenomena, such as turbulent buffeting and fluid loss  
11 -- instability, that we have, we probably, we expect  
12 less wear.

13                  MEMBER BALLINGER: Well, yeah, but there's  
14 no database.

15                  MR. SPENCER: There's no database.

16                  MEMBER BALLINGER: Yeah. Okay.

17                  MR. SPENCER: Right. We would --

18                  MEMBER BALLINGER: So you have to get a  
19 database.

20                  MR. SPENCER: Right.

21                  MEMBER BALLINGER: And the only source of  
22 a database is your first customer.

23                  MR. SPENCER: Right.

24                  MR. SCHULTZ: Kevin, is this time to be  
25 done as part of the ITAAC? The program, the way

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1 you've presented it so far, you've got even  
2 calculational work to do and analyses development to  
3 do before you determine what the inspection program  
4 needs to be. And if you haven't defined the extent of  
5 the program --

6 MR. SPENCER: That is correct. And we  
7 will address that in the following slides. We have a  
8 path forward that other people will be presenting that  
9 will kind of go through that.

10 In terms of the steam generator inspection  
11 program, however, because it's part of the technical  
12 specification of the plant, our recommendations to the  
13 steam generator inspection program will follow ITAAC.  
14 So we would have the, any work that we're, as we're  
15 going to discuss that will be performed to close ITAAC  
16 will inform the development of the steam generator  
17 inspection program.

18 MR. SCHULTZ: Thank you.

19 CO-CHAIR KIRCHNER: Kevin, have you, so  
20 when you take the module apart, so to speak, and you  
21 pull this upper section with the containment vessel  
22 and the upper part of the reactor with the steam  
23 generator, the riser and the steam generator, you  
24 would do visual inspections for wear with probes,  
25 remote probes or something.

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1                   Have you considered, unlike in a large LWR  
2 where the steam generator is some distance away from  
3 the reactor, have you given any consideration to what  
4 the dose would be for people doing these inspections?

5                   MR. SPENCER: Well, go ahead, Kent. You  
6 can handle that.

7                   MR. WELTER: Before I answer that, I'd  
8 like to clarify real quick the last statement on slide  
9 4, the steam generator inspection program is developed  
10 as part of a COL Item. So that work would be prior to  
11 the finalization enclosure of the ITAAC.

12                  Regarding your question on -- forgot it in  
13 my brain. Sorry.

14                  CO-CHAIR KIRCHNER: Visual inspection --

15                  MR. WELTER: Visual inspection.

16                  CO-CHAIR KIRCHNER: -- for wear.

17                  PARTICIPANT: And dose.

18                  MR. WELTER: And dose, yes. Thank you.  
19 Yeah, as part of the FSAR, we looked at dose  
20 calculations for all normal operations and maintenance  
21 and inspections. And so we did do that calculation  
22 for dose of getting in there and putting eddy current  
23 probes up the tubes and inspecting it. We did do  
24 that.

25                  (Simultaneous speaking.)

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1 MEMBER MARCH-LEUBA: All these inspections  
2 are performed under 40 feet of water. Do you send in  
3 divers?

4 MR. WELTER: No, some are when you're  
5 looking at the lower part. The upper assembly gets  
6 put into what's called a dry dock area. And we can  
7 flood up that dry dock to certain levels to reduce the  
8 dose primarily around the flange, which gets kind of  
9 hot there at the bottom. So we can flood it up to  
10 there. But then we have access ways to get into the  
11 plenum where we can inspect not under water.

12 MEMBER MARCH-LEUBA: So the flow  
13 restrictors that you have to remove and put back in,  
14 are they put by hand or remotely?

15 MR. WELTER: It's not a robot, no, if  
16 that's what you're saying.

17 MEMBER MARCH-LEUBA: So --

18 MR. WELTER: We have a set of rigging and  
19 equipment that will be designed --

20 MEMBER MARCH-LEUBA: No, but there are  
21 human eyes.

22 MR. WELTER: Correct, getting in there and  
23 being able to look and take those out and inspect it.

24 MEMBER BALLINGER: Current LWR or PWR  
25 steam generators, they're all, it's all robotic.

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1 There's --

2 MR. WELTER: There's a certain amount of

3 --

4 MEMBER BALLINGER: -- specialized tools  
5 that --

6 MR. WELTER: Sure.

7 MEMBER BALLINGER: -- have been unveiled  
8 so you can do a couple of seconds per inspection.  
9 Would you anticipate a robot kind of implementation  
10 for this kind of inspection, because that's -- if you  
11 have to do it by hand, boy, it's going to take a, ooh,  
12 long time.

13 MR. WELTER: Those, the exact way that  
14 we're doing it with robots are not as under  
15 development. But the way that we did the dose  
16 calculations is we had a fair amount of manual  
17 inspection.

18 But we don't currently have a fully  
19 robotic system in mind that goes in there and attaches  
20 to the plates and inspects them. So --

21 MR. SPENCER: With respect to the IFR  
22 particularly, they would be treated like any sort of  
23 removable hardware. We'd have to, like a manway,  
24 where you'd have to have someone pull that off by  
25 hand. And then once the hardware was removed and the

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1       tubes had entrance, then you could, you know, begin  
2       the eddy current inspection using a robotic  
3       technology.

4                    MEMBER MARCH-LEUBA: Yeah, my concern is  
5       more when you put it back in. That plate has a couple  
6       hundred IFRs, maybe 300.

7                    MR. SPENCER: One IFR for every tube. So

8       --

9                    MEMBER MARCH-LEUBA: Yeah.

10                  MR. SPENCER: -- it would be about 1,380  
11       total.

12                  MEMBER MARCH-LEUBA: But each plate --

13                  MR. SPENCER: Right.

14                  MEMBER MARCH-LEUBA: -- right?

15                  MR. SPENCER: Right.

16                  MEMBER MARCH-LEUBA: It's going to be very  
17       difficult. I mean, I could not possibly align that  
18       many tubes in there. I mean, do you have an aligning  
19       tube or something?

20                  My concern, which I'll bring up later, is  
21       when you do this operation, you're going to be  
22       scratching the IFR and you're scratching the tube.  
23       And you are going to change the clearances around the  
24       IFR and changing the k-effective, by k-effective I  
25       mean the --

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1                   MR. SPENCER: -- efficient.

2                   MEMBER MARCH-LEUBA: -- not the neutronic  
3                   k-effective.

4                   MR. SPENCER: Right.

5                   MEMBER MARCH-LEUBA: And I want to ask you  
6                   later if you have it all the way to how much  
7                   degradation you're going to have on the IFR, effective  
8                   IFR over 60 years of operation.

9                   MR. SPENCER: That would be a good topic  
10                  to discuss during the closed session, yes. So I think  
11                  that wraps up my side. And I'll turn it over to Kent.

12                  MR. WELTER: Thank you. Again, my name is  
13                  Kent Welter. I was going to introduce briefly the  
14                  phenomenon of density-wave oscillation. We were asked  
15                  by the ACRS to present on that. So I have a few  
16                  slides in the open session, and then we have more  
17                  opportunity in the closed session.

18                  This is -- so, as we've touched on,  
19                  density-wave oscillation is a phenomenon that is  
20                  unique to a once-through steam generator or any  
21                  channel where you have a two-phase flow in that  
22                  channel from subcooled, from a subcooled liquid to  
23                  some sort of a boiling.

24                  And the idea is with the right set of  
25                  conditions, you can have a self-sustaining cycle where

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1 you have flow oscillating. And this picture shows  
2 just an example of how that flow oscillation could  
3 begin and become self-sustaining.

4 The reason why it's called a density wave  
5 is the idea is if you're starting out with boiling in  
6 the channel and you excite the system in some way, say  
7 you reduce the inlet flow, you can have a change in  
8 the thermal-hydraulics in the two-phase flow if you  
9 transfer such that voids would form.

10 And as that void travels up that channel,  
11 or in this case the helical coil steam generator, that  
12 can impact the local pressure drop, and that changes  
13 the total pressure drop. And under the right set of  
14 conditions, you can have a self-sustaining cycle where  
15 the flow and the pressure are completely out of phase.

16 And so it's an important phenomenon to try  
17 and design for when you're looking at once-through  
18 steam generators. It's a known phenomenon. It's been  
19 studied for quite a while.

20 And I think we touched on briefly that the  
21 things that we need to make sure are, first off, from  
22 a flow perspective, that you can control the system  
23 under those conditions. If you have them, you need to  
24 be able to understand when you have the density-wave  
25 oscillations and under what conditions.

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1 You try -- as steam generator designers,  
2 the idea is to eliminate them and reduce the  
3 consequences of them. And that's what the inlet flow  
4 restrictor designs tend to do.

5                   And in the closed session, we'll give you  
6                   a little bit more detail on some of the competing  
7                   parameters associated with designing an IFR for this  
8                   particular steam generator. But this is the basic  
9                   phenomenon.

10 And what we are concerned about or make  
11 sure we design for also is the thermal oscillation.  
12 So the flow in itself is not necessarily the most  
13 important thing from a once-through steam generator  
14 perspective. It's the temperature fluctuations and  
15 what does that do on fatigue.

16 And we've also touched on the wear  
17 aspects. We'll also talk about how the velocities  
18 inside the tubes, on the outside of tubes are not very  
19 high. And we don't really expect any additional wear  
20 characteristics that we haven't considered already due  
21 to density-wave oscillations.

22 So what we're primarily focused on is the  
23 thermal-hydraulics and the thermal fatigue  
24 perspective.

25 MEMBER MARCH-LEUBA: Let me just bring up

1 a concept. And we'll discuss it in the closed  
2 session.

3 Whenever you've got these flow-induced  
4 oscillations, the steam wave, they always grow very  
5 large. I mean, there is no such thing as a small  
6 oscillation because there is nothing to stop them.  
7 Once they want to go, they go. And you always end up  
8 having reverse flow, yeah.

9 And the inlet, you have the IFR, the inlet  
10 flow restriction, which is a very tight flow area and  
11 expansion and contraction to get -- where you have a  
12 very high velocity during normal operation.

13 When you have reverse flow, you have that  
14 same velocity or maybe twice as much. But now with  
15 the same mass flow rate, you have 40, 80, 90 percent  
16 void fraction going down the flow restrictor, meaning  
17 that the liquid velocity and the flow restriction on  
18 the reverse side is probably 20, 40 times larger than  
19 on the forward side.

20 And not only that, it has void. So, in a  
21 sense, your IFR is cavitating. Okay. I mean, you  
22 have voids. You have 20, 30, 40 times the 3,000  
23 percent velocity that you had in a normal direction.  
24 And all that is impinging on that plate that is  
25 holding that IFR in a cantilever way from a bolt.

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1                   And when we go to the proprietary section,  
2 I'll ask you to give me the confidence that you have  
3 in that analysis, that that thing doesn't vibrate.

4                   MR. WELTER: Understood.

5                   MEMBER MARCH-LEUBA: But the concept is  
6 perfectly open. And then we'll talk about numbers.

7                   MR. WELTER: Sure, yeah. And we'll talk  
8 about some of the, from the data we have from the TF-1  
9 and TF-2 experiments that provides us information on  
10 what we consider to be a bounding density of  
11 oscillation transience.

12                  You need to assume something in the  
13 thermal fatigue analysis and the assumptions on the  
14 film coefficient right where that inlet flow  
15 restrictor is and talk about --

16                  MEMBER MARCH-LEUBA: We'll --

17                  MR. WELTER: -- the details of that in the  
18 closed session.

19                  MEMBER MARCH-LEUBA: Let's go over this  
20 so we can go into the closed session --

21                  MR. WELTER: Understood.

22                  MEMBER MARCH-LEUBA: But my question on  
23 the open is that the IFRs are hundreds of cantilever  
24 bars held by a bolt into a common plate which has been  
25 impinged by cavitating flow or high velocity.

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1 MR. WELTER: Understood. Okay. Next  
2 slide.

As mentioned in the FSAR, density-wave oscillations are mentioned a number of times. In Revision 3 of the DCA, Section 3.9.1 discusses the possibility of secondary flow oscillations.

7                   In our analysis that we've been doing so  
8 far, it's primarily in the power ascent and descent or  
9 in the low power range, around 0 to 20 percent.  
10 That's --

11 MEMBER MARCH-LEUBA: Keeping it at a very  
12 level, and we'll talk about it later.

13 MR. WELTER: Sure.

14 MEMBER MARCH-LEUBA: The TF-2 tests have  
15 been analyzed by two groups of people that I know of,  
16 you and the staff. And you guys disagree with the  
17 conclusions. And for the record, I trust your  
18 calculation better than the staff because yours was a  
19 little more detailed.

20                   But just say that there are two opinions  
21                   on that statement you just made, that it only happens  
22                   on the ascent. There is an opinion on paper on your  
23                   SCR --

24 || MR. WELTER: True, yes.

25 MEMBER MARCH-LEUBA: -- that this, that

1       your full power operation is unstable. And we  
2 definitely need to address that.

3                    MR. WELTER: Understood, yes. And we  
4 recognize that disagreement. We'll talk about that in  
5 the closed session. Thank you.

6                    MEMBER MARCH-LEUBA: It has to be cleared  
7 up because --

8                    MR. WELTER: Understood.

9                    MEMBER MARCH-LEUBA: -- when I see two  
10 different opinions, what I tell anybody is that one of  
11 them is wrong and most likely both are wrong because  
12 otherwise you would have agreement.

13                  MR. WELTER: Understood. In the FSAR in  
14 Section 5, we talk to the inlet flow restrictor  
15 design, that stepped orifice design, or not orifice,  
16 stepped flow restrictor design and that limits DWO  
17 under acceptable limits where acceptable limits are  
18 ASME stress calculations or fatigue limits.

19                  And Kevin will talk a little bit about  
20 more what the ASME stress calcs that we're doing.

21                  PARTICIPANT: Joe.

22                  MR. WELTER: Joe. I'm sorry.

23                  MEMBER MARCH-LEUBA: On this point, I'm  
24 going to reinforce what I said before. The FSAR has  
25 the blanket statements about what may or may not

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1 happen after you finish your calculations five years  
2 from now. And I don't think it's appropriate to have  
3 that language on the, without any basis.

4 MR. WELTER: Understood. Well --

5 MEMBER MARCH-LEUBA: Section 5.41 --

6 MR. WELTER: Yeah.

7 MEMBER MARCH-LEUBA: -- I mean, it's  
8 wishy-washy. I mean, everything is just one sentence  
9 -- everything is good.

10 MR. WELTER: Understood. It has those --

11 MEMBER MARCH-LEUBA: And I don't have any  
12 document or any calculation that backs up that  
13 statement.

14 MR. WELTER: Understood. And we'll talk  
15 a little bit about the preliminary work that we're  
16 doing to meet those limits as part of the downstream  
17 activities.

18 MEMBER MARCH-LEUBA: Very simple, FSAR  
19 said as part of ITAAC so-and-so, we will ensure that  
20 the flow restriction is doing that, instead of saying  
21 the flow restriction, that's it. We're wanting to  
22 demonstrate it, but we have not yet.

23 MR. WELTER: And I think we recognize  
24 that. And we did visit with the staff regarding the,  
25 to my last bullet there, the specific language in the

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1 DCA.

2 MEMBER MARCH-LEUBA: I would strongly  
3 encourage that language to be changed, because as it  
4 is, it's not accurate. It's likely to be. But it's  
5 not accurate.

6 MR. WELTER: Right. And --

7 MEMBER BLEY: That's true. But there's a  
8 lot of other places in the FSAR the same thing  
9 applies.

10 MEMBER MARCH-LEUBA: I'll leave that to  
11 you.

12 MEMBER BLEY: I can't do the whole thing.  
13 But there are quite a few places where this, not, this  
14 is not what we expect, this is the way the world is,  
15 and nothing to back it up.

16 MR. WELTER: No, but I agree. And in  
17 terms of the language related to the IFR design and  
18 the use of RELAP, we're planning to revisit that and  
19 see if we need to make some changes. And we've  
20 started that discussion with the staff.

21 MEMBER MARCH-LEUBA: Let me put another  
22 concept, which I don't think is proprietary. The use  
23 of RELAP for secondary side instability calculations  
24 is explicitly forbidden on your topical report that we  
25 will be reading in a couple of weeks. I mean, it's a

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1 limitation of the topical report. So we need to  
2 address that, too.

3 MR. WELTER: Yeah, and we --

4 MEMBER MARCH-LEUBA: You're using a tool  
5 that that guide explicitly forbids you from using for  
6 this application.

7 MR. WELTER: Right --

8 MEMBER MARCH-LEUBA: And I keep forbidding  
9 not because it's bad but it's because he didn't review  
10 it for this application.

11 MR. WELTER: Understood. And so that's  
12 why we have here in the third bullet this, I believe  
13 you're talking about the stability topical report.

14 MEMBER MARCH-LEUBA: The non-LOCA --

15 MR. WELTER: The non-LOCA. I'm sorry.  
16 Yes.

17 MEMBER MARCH-LEUBA: -- has a limitation  
18 on ASA. And RELAP is good for everything except the  
19 secondary side instability. Is it the non-LOCA or is  
20 it LOCA? It's one of the two, both.

21 MR. WELTER: Right. There is some certain  
22 limitations on RELAP. And in the closed session,  
23 we'll talk about the planned use for RELAP forward,  
24 analyzing the density-wave oscillations, some of the  
25 reassessments we did, and the limitations of RELAP and

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1 how those need to be addressed. Correct?

2                   Okay. So you -- so I think that's it for  
3 me on the open session. So I'd like to turn it over  
4 to Joe now.

5                   MR. REMIC: Thank you, Kent. Good  
6 morning. My name is Joe Remic.

7                   I will be talking to you a little bit  
8 today about NuScale's plan associated with DWO in  
9 regards to our ITAAC closure plan. I'll then be going  
10 into briefly ASME design specification and design  
11 reports. And then I will be closing out my portion of  
12 today's presentation with some of our preliminary  
13 results.

14                   So, first, ITAAC 02.01.01 requires the  
15 inspection of an as-built ASME design report for a  
16 variety of different ASME code class components, 1, 2,  
17 3, as well as a variety of other things.

18                   So what does this mean in relationship to  
19 the steam generator for us? Well, Table 2.1-2, and as  
20 part of our tier 1 document, identifies the ASME code  
21 class of numerous components.

22                   And as you can see here from this snippet,  
23 both the RCS-integral RPB and the steam generator are  
24 classified as ASME code, Section 3, Class 1  
25 components. Therefore, ITAAC 02.01.01 will require

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the inspection of an ASME as-built design report for the steam generator, as well as the corresponding components of the RPD.

4 MEMBER RICCARDELLA: What do you mean by  
5 the word inspection in those bullets?

6 MR. REMIC: So --

7 MEMBER RICCARDELLA: I mean, you have to  
8 do preparation of the, of a design report. You have  
9 to have a third-part review. But the inspection --

10 MR. REMIC: So the inspection --

11 MEMBER RICCARDELLA: -- by the staff you  
12 mean?

13 MR. REMIC: Yes.

14 MEMBER RICCARDELLA: Oh, review, okay.

15 MEMBER MARCH-LEUBA: In that spirit, and  
16 I would ask the staff to prepare for their  
17 presentation, when I was reviewing this slide --  
18 because this is the first documentation I have of how  
19 this is going to be solved is this slide. And there  
20 is no documentation anywhere else. It's not on the  
21 SCR. It's not on the FSAR. It's on this slide.

I was looking at this. And I just don't feel -- and this is my gut feeling, which is not approved for use in the laboratory environment.

But my gut feeling is that this topic is

1       not an ITAAC topic. This is more like an open item.  
2       I mean, I would call this an open item. This is not  
3       an inspection and test. This is we have not finished  
4       our analysis.

5                 And you move to ITAAC items like you don't  
6       know where the cooling tower is going to be because in  
7       some plants it will be in the northwest and some  
8       plants, some sites it will be in the northeast.

9                 But this has still been an issue we  
10      haven't decided -- is finalized. There is no excuse  
11      not to have the analysis of the -- certification.

12                I mean, this is an open item in my  
13      opinion. And I just said my opinion. While I say  
14      this, this is a subcommittee meeting. All you're  
15      hearing here is individual members' opinions. If you  
16      are in this room, you have this oral --- it's good to  
17      put it on the record.

18               CO-CHAIR KIRCHNER: No, I did say in the  
19      opening statement that we only, our conclusions, et  
20      cetera are done through our letter reports.

21               MEMBER MARCH-LEUBA: Yeah.

22               CO-CHAIR KIRCHNER: So, yes.

23               MEMBER MARCH-LEUBA: Whenever you hear  
24      some of these things and when we write a letter, we  
25      remember what we said. We might include it. And then

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1 there will be a vote among the committee whether we,  
2 the committee agrees or not. So what you're hearing  
3 from me is my opinion.

4 MR. REMIC: Okay.

5 MEMBER MARCH-LEUBA: But my opinion is  
6 that this is not an item, this is not an item.

7 MEMBER SUNSERI: Is this ITAAC a common to  
8 all design certifications, or is this a specific thing  
9 for NuScale?

10 MR. BRYAN: Yeah, this is, my  
11 understanding, common to all from the ones I've looked  
12 at --

13 CO-CHAIR KIRCHNER: This is an ASME code  
14 requirement.

15 MR. BRYAN: Right, right.

16 CO-CHAIR KIRCHNER: This is not a design  
17 issue per se. It's, as you just presented, this is --  
18 I'm not an expert on the code. But I'm familiar with  
19 it. And this is a Section 3, Class 1 vessel. So this  
20 is a requirement to meet the ASME boiler and pressure  
21 vessel code. It's not unique to NuScale.

22                   But I share Jose's concern that this is  
23 not addressing the design issues. This is just  
24 meeting the requirements of the ASME code.

25 MEMBER BLEY: It is. But --

1 CO-CHAIR KIRCHNER: Yeah.

2 MEMBER BLEY: -- they are going back many  
3 years on these design certs. We have argued that at  
4 other times. There is a whole series of IEEE  
5 requirements that have to be documented in the  
6 reports. No reason some of those couldn't have been  
7 done earlier. But they're done as ITAACs. So  
8 there's, ITAACs are full of this sort of thing --

9 MR. REMIC: Just --

10 MEMBER BLEY: -- whether we like it or  
11 not.

12 (Simultaneous speaking.)

13 CO-CHAIR KIRCHNER: No, this -- I think  
14 Jose's point is subtly different. This slide, this  
15 ITAAC to do the ASME code requirement would apply to  
16 anyone who had this kind of vessel under Section 3,  
17 Class 1.

18 MEMBER BLEY: It's no different than the  
19 --

20 CO-CHAIR KIRCHNER: It's no different,  
21 yeah. But I think what you're getting at --

22 MEMBER BLEY: In the ITAAC, there should  
23 be a report that documents it.

24 MEMBER MARCH-LEUBA: There is an  
25 expectation that the pressure vessel would satisfy the

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1 ASME code, Class 1. Right now we don't have any  
2 evidence that the steam-to-flow instability would  
3 satisfy ASME 1.

4                   Before I certify your steam generator, I  
5 should have some expectation that it will work. And  
6 therefore, I should have some of these calculations  
7 done.

8                   I mean, you know the difference, because  
9 when you have a steam line, there is an expectation  
10 that we know how to do them and there is no problem.  
11 We are raising issues about very large flow  
12 oscillations in the steam generator which don't happen  
13 in any other steam generator or in the majority of the  
14 steam generators in the world. And therefore, this  
15 requires a little more effort.

16                  MR. REMIC: No, I understand. And I  
17 appreciate that. I just -- the level of pedigree of  
18 our analysis is consistent with other applications  
19 historically in the past, in which what we plan on  
20 doing and what I'll be discussing here today is, as  
21 you indicated, we are going to be performing the full  
22 Section 3 evaluations of these components.

23                  And we will be documenting all of those  
24 requirements in an ASME design report. But as you can  
25 see here, in regards to the DWO loading specifically,

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Subsection NCA of the ASME code provides a series of different requirements on what needs to be included in both ASME design specifications and ASME design reports.

5 So, in order to connect the dots, the  
6 ITAAC requires the inspection of an ASME as-built  
7 design report. In order for an ASME as-built design  
8 report to occur or to be constructed, there needs to  
9 be an ASME design specification.

Within that ASME design specification, as you see on this slide here, according to NCA-2142.2, a subsection of the ASME code, all corresponding loads need to be defined, both thermal, mechanical, the corresponding cycles, the service level conditions, as well as the load combinations.

16 So, within our ASME design specification  
17 for the RPd and the steam generator, we will have to  
18 have the DWO event defined as part of that.

19 MEMBER MARCH-LEUBA: Right. But this is  
20 what -- go ahead.

21 MEMBER RICCARDELLA: You know, if I go  
22 back early, I spent the first ten years of my career  
23 preparing ASME Class 1 stress reports. And that, of  
24 course, was under the Part 50 applications.

25 But, I mean, they weren't done until the

vessels, the steam generators were being built. I  
mean, it's the vendor who -- you know, you issue a  
contract. You're going to build the vessel. They're  
the ones that are responsible to prepare the design  
report.

6                   But what is your responsibility I think is  
7                   to prepare the design specification, as you said, that  
8                   defines the loads. And you would have to define these  
9                   density-wave oscillations as part of that design spec.  
10                  Is it the intent to do that prior to certification,  
11                  the design spec? No?

12 MR. WELTER: Currently, it's not part of  
13 -- it's downstream activity.

14 MEMBER RICCARDELLA: Okay.

15 MR. WELTER: Yeah, it's separate from  
16 that. It's part of the downstream activities that  
17 would need to be completed for the ITAAC.

18 MEMBER MARCH-LEUBA: Let me oversimplify.  
19 People get upset when I do that. But basically what  
20 I hear from you is stress test will do a good job  
21 later. That's what I hear.

22 MR. WELTER: And that is the basis of the  
23 ITAAC concept, where you are making future commitments  
24 that need to be addressed.

25 MEMBER MARCH-LEUBA: What I see missing

1 here from the point of the staff is there has to be an  
2 agreement on what the methodology will be to define  
3 those loads.

4                   For example, you never even thought about  
5 the reverse flow on the IFR with two-phase flow going  
6 through it. I mean, this is a concept you just  
7 realized right now. I'm making a statement. If I'm  
8 wrong, let me know.

9                   MR. BRYAN: I believe that's an inaccurate  
10 statement.

11                  MR. WELTER: That's incorrect. And we  
12 have considered reverse flow and --

13                  MEMBER MARCH-LEUBA: And you -- the  
14 reverse flow with very high void fraction and all  
15 those loads in the plate.

16                  MR. WELTER: It's part of our methodology  
17 to look at that, yes. Yeah, again, we're --

18                  MEMBER MARCH-LEUBA: So --

19                  MR. WELTER: We're looking at the data and  
20 the operating experience from other things that we  
21 have lessons learned from and incorporating that in  
22 the methodology. And we are considering reverse flow.

23                  MEMBER MARCH-LEUBA: I haven't seen it on  
24 your slides. Do your slides say I put a swear word in  
25 temperature and it failed?

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1                   MR. WELTER: On one of them, to be fair.

2 On the other one, it passed and one where it did not.

3 So --

4                   MEMBER MARCH-LEUBA: But all I've seen on  
5 the FSAR is this IFR is a very stiff rod. It has very  
6 high frequency and musn't vibrate.

7                   MR. WELTER: Right. There's a level of  
8 detail that's not in the FSAR regarding the  
9 methodology. The methodology is not --

10                  MEMBER MARCH-LEUBA: My point where I'm  
11 trying to get to is that the use of RELAP for those  
12 calculations or TF-2 data, if it's from banding or TF-  
13 1 or TF-7, whatever it is, should be, in my opinion,  
14 it should be a topical report like it's agreed -- the  
15 methodology that you would use to calculate the ASME  
16 code limits should be agreed upon with the staff. And  
17 you cannot make it up and just give me the results.

18                  Somebody that actually is overseeing over  
19 your shoulder and has no concern about how much it  
20 costs should look at it and ensure that the  
21 methodology is sound. And the way I see the path  
22 foreclosure, there is no review of the methodology.

23                  MR. WELTER: So I do have a slide in the  
24 closed session. And there's a bullet. I think it's  
25 slide 21, that I can talk in more detail about an

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1 opportunity for the staff to review the methodology  
2 prior to that ITAAC closure.

3 MEMBER MARCH-LEUBA: Yeah, it mentions  
4 they have an opportunity --

5 MR. WELTER: They have an opportunity to  
6 do that, correct, yeah.

7 MEMBER MARCH-LEUBA: Yeah. I would rather  
8 to see a commitment on the topical report for review.  
9 I mean, this is important. This is the only steam  
10 generator in the world that is planning to operate in  
11 a unstable mode.

12 MEMBER BALLINGER: But to circle back a  
13 little bit on the materials issue, in the, and with  
14 respect to the code, what got the San Onofre people  
15 was the fact that there were some words, and I'm  
16 paraphrasing, in the code that says as long as your  
17 design is within a certain envelope of history you  
18 don't have to do extensive experiments. And I'm  
19 paraphrasing.

20 What happened was the design was outside  
21 the, it turned out to be outside of the experience.  
22 And under those conditions, the code requires  
23 additional experiments and validation.

24 Is your design within the envelope of  
25 existing data for tube wear and things like that? Are

1       you making that claim, and therefore, you don't have  
2       to worry about doing additional experiments to verify  
3       the wear models? I could probably find the exact  
4       words --

5                    MR. WELTER: No, I'm try to get --

6                    MEMBER BALLINGER: -- in the code. But --

7                    MR. WELTER: So we are doing -- so I think  
8       what we're trying to do in the conversation is make  
9       distinctions between what we need to consider from a  
10      flow-induced vibration perspective, and we are doing  
11      testing for that right now, and the tests that we have  
12      done already for density-wave oscillations that again  
13      are primarily looking at thermal-hydraulic conditions  
14      at which they would occur, and the effectiveness of  
15      the IFR design, and making sure that we have the right  
16      thermal transient for fatigue calculations.

17                  MEMBER BALLINGER: But this is --

18                  MR. WELTER: They're two separate --

19                  MEMBER BALLINGER: This is kind of a  
20      little gray area where the cause of the wear might be  
21      different than the cause of the wear in a u-tube steam  
22      generator. And so --

23                  (Simultaneous speaking.)

24                  MR. WELTER: And we've done --

25                  MEMBER BALLINGER: Okay.

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1                   MR. WELTER: -- significant testing to  
2 look at, in considering wear and providing the  
3 allowances for this specific steam generator.

4                   MEMBER RICCARDELLA: And that's TF-1 and  
5 TF-2. And you're pursuing TF-3, right?

6                   MR. WELTER: Currently TF-3 for the FIB  
7 testing. That's correct.

8                   CO-CHAIR KIRCHNER: I propose that we let  
9 the NuScale staff go through the remaining slides  
10 because I think they will address some of the  
11 questions or at least tee them up for the closed  
12 session. Could we do that? Is it --

13                   (Off mic comments.)

14                   CO-CHAIR KIRCHNER: All right. Please.

15                   MR. REMIC: Thank you. So once the DWO  
16 transient definition as well as all the other  
17 transients and service conditions are defined within  
18 the design specification, an ASME design report will  
19 be constructed.

20                   That design report, as you can see from  
21 the various subparagraphs identified on this slide,  
22 will require that a registered professional engineer  
23 certify that all loads and all load combinations  
24 defined within the design specification are  
25 appropriately met.

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1 And that registered professional engineer  
2 has to be competent in the field in which they're  
3 performing the evaluation that's being performed.

9 So all this together means that the DWO  
10 loading will have to be defined within the design  
11 specification, the corresponding loadings, the load  
12 combinations associated with that event, as well as a  
13 variety of other events on the steam generator, will  
14 then have to be analyzed successfully in a design  
15 report.

20 I now would like to go over a little bit  
21 about our preliminary results that we have handled  
22 thus far.

23 So specifically, the steam generator tube,  
24 so we have performed a preliminary evaluation on the  
25 steam generator tubes. We have modeled the entire

1 length of the steam generator tubes.

2                   We applied the primary side conditions on  
3 the primary side. And then we assumed DWO full flow  
4 reversal. We assumed the entire length of the tube  
5 was in the subcool region. And then the entire length  
6 of the tube was also then in the super-heated region.  
7 And we oscillated that for a variety of different  
8 power levels.

9                   And what we were able to conclude for the  
10 steam generator tubes in this preliminary evaluation  
11 is that the resulting, or excuse me, the resulting  
12 alternating stress of the, due to DWO on the steam  
13 generator tubes is below the endurance limit.

14                   And what that effectively means is that  
15 the steam generator tubes can withstand an infinite  
16 number of cycles of DWO without incurring any fatigue  
17 damage.

18                   MEMBER SUNSERI: This doesn't address  
19 Professor Ballinger's questions about wear.

20                   MEMBER BALLINGER: That's the gray area.

21                   MR. REMIC: That is true. This evaluation  
22 was highly focused on thermal fatigue. We had  
23 performed separate evaluations concerning the  
24 mechanical stresses imparted due to vibration and  
25 other thing, other such loadings due to DWO. And we

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1 concluded that they were negligible in nature.

2                   However, wear on the steam generator tubes  
3 outside of DWO, as Kevin and others have indicated,  
4 will be considered and has been considered. And we  
5 are --

6                   MEMBER RICCARDELLA: We had a whole day-  
7 long presentation on that by the professor from Penn  
8 State. Do you remember that? I mean, they've done  
9 extensive flow-induced vibration work. And --

10                  (Off mic comments.)

11                  CO-CHAIR KIRCHNER: Well, Pete, that was  
12 flow-induced vibrations, which --

13                  MEMBER RICCARDELLA: Yeah, but I think  
14 we're conflating two different subjects here. DWO is  
15 different. That's a thermal-hydraulic phenomenon  
16 versus the wear --

17                  CO-CHAIR KIRCHNER: No, but the concern  
18 for the DWO in the tubes is that they will shrink and  
19 expand. And then you have a three-point clip that is  
20 holding up the tube.

21                  So, you know, normally if it was just  
22 steady state, you would expect that the helical coil  
23 tube would expand very tight fit against those support  
24 structures and clips. But if it's oscillating, then  
25 you have to be concerned about whether that becomes a

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1 migratory or a wear issue --

2 MEMBER RICCARDELLA: Wear due to DWO.

3 CO-CHAIR KIRCHNER: -- at the support.

4 And that was not discussed --

5 MEMBER RICCARDELLA: Yeah.

6 CO-CHAIR KIRCHNER: -- previously.

7 MR. REMIC: Yes, so I know that we do have  
8 plans to finalize evaluations concerning wear due to  
9 thermal expansion. I do believe that our conclusions,  
10 as indicated by Kevin and others on the NuScale staff,  
11 are such that the wear due to DWO will not be -- we  
12 will -- we are considering that, but I cannot comment  
13 on the pedigree of that evaluation at this time.

14 MR. WELTER: Yes, we have done some  
15 preliminary calculations to look at that and we'll see  
16 if we can't get someone on the line to talk a little  
17 bit about that in the closed session.

18 CHAIR KIRCHNER: And that would have to go  
19 into your specifications for the ASME report?

20 MR. WELTER: Yes, we didn't prepare the  
21 slides associated with that, but I'm going to see if  
22 we can't get some more information on that  
23 specifically.

24 And just at a high level, although we have  
25 this oscillatory nature, I mean when you look -- and

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1       we'll talk -- Kevin will talk about from a fatigue  
2       perspective it's a quasi-steady state kind of a thing.  
3       It's not -- the frequency at which it oscillates is  
4       not something that we would be particularly concerned  
5       with from a wear perspective. It would be more of a  
6       second-order effect when you're comparing it to wear  
7       associated with flow-induced vibration. I mean it's  
8       not -- we have looked at it. It's not something we're  
9       concerned about because of again the quasi-steady  
10      state nature of those temperature transients and  
11      because -- yes, anyway.

12                  MEMBER MARCH-LEUBA: It was a second --  
13                  it's not --

14                  MR. WELTER: Yes.

15                  MEMBER MARCH-LEUBA: It's not the 100  
16      hertz, right?

17                  MR. WELTER: I know, but it's not like  
18      you're chugging in an -- it's a different type of  
19      phenomenon, the wear associated with the outside of  
20      the tubes and the flow-induced vibration and the wear  
21      that potentially could be caused by the fluid in the  
22      columns going up and down and creating a thermal  
23      transient. And so they're different. And so I'm  
24      going to see if we can't get someone on the line to  
25      try and make that distinction a little bit more --

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(Simultaneous speaking.)

2 MR. SPENCER: I can speak to some of the  
3 general effects of it.

4 MR. WELTER: Okay. Maybe Kevin can.

5 MR. SPENCER: With respect to wear due to  
6 DWO, one thing that we -- I've identified during our  
7 preliminary scoping analyses is that the temperature  
8 fluctuations happen kind of along the length of the  
9 tube. Because of the helical design in a rough sense  
10 each tube is making circular orbits. The supports  
11 that we have are -- act on a very small part of the  
12 tube, so there's a very large span from support to  
13 support where the tube is loose and able to displace.

24 So we see that -- we expect generally that  
25 given thermal loadings -- changes in temperature of

the tube on two sides of the support will provide some sort of balancing effect with respect to the reaction forces at that support, and most of that thermal stress will be taken up as additional bending in the free span of the tube.

6 MEMBER MARCH-LEUBA: Maybe it's because I  
7 don't know anything about this; and I will let Dr.  
8 Ballinger worry about it, but I'm not worried about  
9 the -- I don't think we're worried about the stress or  
10 strain on the tube. We're talking about the tube is  
11 loose, but it's rubbing. So there is nothing  
12 preventing it from moving. And you're talking quasi-  
13 steady state, 100-150 degrees change in temperature  
14 every second. And if it's not -- if that support is  
15 not very tight, it will move and rub. It can.

24 And then that again goes back to our steam  
25 generator inspection program where we'd be monitoring

the wear rates and we would be looking for increased  
n rate, or we may see wear that happens once and as  
the steam generator kind of wears into its support.

4                   But in terms of the wear due to DWO,  
5 because the thermal axial growth of the tube is  
6 occurring on both sides of the supports, we don't see  
7 that there's very much differential motion there  
8 between the two, especially considering the long  
9 unsupported span which can take up the additional  
10 strain in terms of a bending stress.

11 MEMBER MARCH-LEUBA: The important thing  
12 is you tell me have analyzed it, which I haven't seen  
13 an analysis.

14 MR. SPENCER: Right, that's been included  
15 in our preliminary work that we're kind of discussing  
16 today, but that preliminary work has not been subject  
17 to inspection at this point.

18 MEMBER MARCH-LEUBA: So and your  
19 expectation is if the staff wants to audit your work  
20 under Corvallis, or is this going to be part of the  
21 certification?

22 || MR. SPENCER: I'm sorry, could you --

23 || (Simultaneous speaking.)

24 MEMBER MARCH-LEUBA: Yes, your expectation  
25 about this is you plan to do the work in Corvallis and

1 if the staff wants to go and audit it, they're welcome  
2 to come, or is this part of the review?

3 MR. BRYAN: Well, I think from our  
4 perspective the review is completed. That would have  
5 to be addressed elsewhere. I think we would have to  
6 discuss that. It's not our plan that it would be  
7 inspected per se, but it's part of our normal design  
8 completion activities.

9 MEMBER MARCH-LEUBA: Yes, but you will  
10 agree that -- everybody will agree that it's not  
11 desirable to have this oscillations happening every  
12 one second inside your steam generator. It's not. So  
13 it's an unusual circumstance in this particular  
14 design. So whereas the staff is not going to audit  
15 the ASME Code for the steam line because they trust  
16 you. On this one they should. I mean it's just an  
17 unusual circumstance. I'm just leaving it for --

18 MR. SCHULTZ: We're talking to the staff  
19 next, but they would -- the other alternative would be  
20 for the staff to conclude that this just isn't a  
21 problem and therefore the place where NuScale is with  
22 regard to the design is not of concern.

23 But I agree with you, Jose. More needs to  
24 be done.

25 And you've talked about inspection in a

number of different ways: professional engineer evaluation, ASME requirements, audits, inspections and so forth. It would be good to get all of that clear so we know who's going to see what when with regard to work that's still ongoing.

6 MEMBER BLEY: It's not completely  
7 relevant, but it is to an extent. Back in the '60s  
8 and '70s when we started having problems in U-tube  
9 steam generators, we solved it and we changed the  
10 chemistry. And then it happened again. And then we  
11 changed the chemistry. We thought we solved it at  
12 least two or three times. Eventually they got there.  
13 We had condenser tube problems with corrosion.  
14 Changed the materials. No more corrosion problems,  
15 but all of a sudden we got fretting problems ripping  
16 the tubes apart.

I think Ron's point earlier about how you  
lay out the surveillance and inspection programs once  
one of these starts up and we track it real closely is  
really crucial to not having events that damage your  
reputation and the industry's. And that doesn't say  
anything about trying to get this analysis part right,  
but that might not solve the whole problem.

24 MEMBER BALLINGER: And I would -- again  
25 basically your ejection seat in this thing is that you

1 can change the inspection interval. And if it's well  
2 designed to start with, you'll avoid -- head off  
3 issues.

4 MR. WELTER: Yes, and we recognize that.  
5 And this is information that's used for developing the  
6 steam generator inspection program, and because it is  
7 a unique steam generator and although we're doing a  
8 lot of work from a design perspective to ensure its  
9 full 60-year life, we will have to get operating  
10 experience and inspect every cycle to figure out --  
11 looking where the wear is. It's 100 percent visual  
12 inspection. The eddy current probe is up there and  
13 every cycle we might have to update the inspection  
14 program for the next cycle.

15 So we fully expect -- which is a COLA  
16 item, the inspection program. So we fully expect  
17 we're going to be taking this apart and looking at it  
18 every cycle and then adjusting the inspection program  
19 as needed. So we don't I think claim to have all the  
20 information today, but that's the order of activities,  
21 the downstream activities to ensure that we put a  
22 steam generator in operation and that we're looking at  
23 it and making the necessary changes as needed when we  
24 get operating data.

25 And that's the plan that we've outlined

1 here in the open session to talk about that through  
2 designing the steam generator, completing ASME design  
3 specs, the ITAAC reports and developing a steam  
4 generator inspection program.

5 CHAIR KIRCHNER: Would you please proceed  
6 to 13 and -- I think we have two slides to go, and we  
7 can finish this and then follow up the detailed  
8 questions in the closed session, please.

9 MR. SPENCER: So our plant closures  
10 activity is through ITAAC. We have the design report  
11 that we'll be issuing. So here's kind of how we will  
12 accumulate all of the data that we'll need to inform  
13 the ASME Code Section 3 Design Report.

14 So entering that five, we'll provide  
15 thermal hydraulic time histories of the design  
16 transience to support our fatigue analysis. These  
17 include fluid temperatures, pressures, nominal flow  
18 rates, quality. And this is the general design  
19 transient inventory not specific to but inclusive of  
20 DWO. We'll use the TF-1 and TF-2 test data to provide  
21 a basis for the parameters that we'll use to calculate  
22 the film coefficients and resulting stresses during  
23 DWO.

24 Because the thermal response of the tube  
25 -- in other words, the thin wall of the tube lends a

1 very fast thermal response to temperature changes due  
2 to changing fluid conditions inside the tube. That  
3 thermal response is much faster than the DWO  
4 frequencies that we've seen as a result of the TF-1,  
5 TF-2 testing. So we can feel confident that we can  
6 perform a quasi-static analysis on the stresses of the  
7 tube.

8 In other words, we can take the peak --  
9 the stress correlating to the peak of one BWR  
10 oscillation and the stress state corresponding to a  
11 trough of a DWO oscillation. We can just look at the  
12 changes in stress between the peak and the trough of  
13 the oscillation as a quasi-static state. We can let  
14 the tube fully come to those thermal conditions and  
15 look at the differences in stress.

16 When we combine that stress with all other  
17 loadings and all other transients, we're going to be  
18 comparing that to allowable stress limits as  
19 prescribed in the ASME Code. And then the goal of our  
20 final ASME calculation of course is to confirm that  
21 any alternating stresses on the steam generator tubes,  
22 the tube to tube sheet weld and the tube sheets, all  
23 steam generator components due to DWO stresses will be  
24 below the ASME endurance limit. Therefore, with  
25 respect to DWO we would be able to withstand infinite

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1 || cycles of thermal oscillations.

2 MEMBER MARCH-LEUBA: Reading in between  
3 lines that you only plan to evaluate the expansion and  
4 contraction of the bulk of the two because of changes  
5 in temperature. That's what you're telling me there.  
6 And we were talking before about reverse flow through  
7 the IFR with significant -- and tremendously high  
8 velocities impacting on the plate that supports those  
9 IFRs.

10 Have you done any analysis? You told me  
11 a month ago that you considered it and that you've  
12 done a significant analysis and decided that was not  
13 a problem. I think it is.

14 MR. SPENCER: So I can -- I will  
15 specifically say that we have considered that we would  
16 have full reversal flow at the tube sheet even though  
17 that has not been -- even that kind of flow has not  
18 been seen in any of the previous testing that we've  
19 done. We haven't seen --

20 MEMBER MARCH-LEUBA: And you will consider  
21 the impact on the expansion of the tube for thermal --  
22 the temperature change?

23                           MR. SPENCER: With respect to the actual  
24 tube analysis.

25 MEMBER MARCH-LEUBA: I'm worried about the

1           localized cavitation --

2                   MR. SPENCER: Right.

3                   MEMBER MARCH-LEUBA: -- of the --

4                           (Simultaneous speaking.)

5                   MR. SPENCER: So I think --

6                   MR. WELTER: Can I jump in real quick?

7                   So, yes, we actually have an activity that we need to  
8                   look at and disposition the -- from a CVAP perspective  
9                   making sure that that high velocity doesn't introduce  
10                  any additional flow-induced vibration and wear. We  
11                  have to do that and it is part of our program. That  
12                  is correct.

13                  MEMBER MARCH-LEUBA: Because that wear --

14                  MR. WELTER: Yes.

15                  MEMBER MARCH-LEUBA: -- will have -- your  
16                  IFR effectiveness?

17                  MR. WELTER: Right, and that's a small  
18                  tolerance there and we've designed that such that it  
19                  -- we have confidence that it won't be an issue, but  
20                  that is in our program to evaluate flow-induced  
21                  vibration right there.

22                  MEMBER MARCH-LEUBA: I don't see it there.

23                  MR. WELTER: It's not this slide, but in  
24                  the -- I have to double check, but on previous  
25                  presentations there is -- when we talked about flow-

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1 induced vibration, there's that bypass flow, and  
2 that's on some of that information. I don't know if  
3 we -- it's not here today, but we have --

4 (Simultaneous speaking.)

5 MEMBER MARCH-LEUBA: My point, to my  
6 colleagues more than you, is that I see the necessity  
7 of developing a methodology to evaluate this problem,  
8 have you review by the staff, by somebody else, not  
9 just by you. Because the plan I see for you is you're  
10 going to calculate the strain and you're going to say  
11 it's 22, which is less 43, and therefore it's okay.  
12 And that's all they're going to see.

I think we need to agree on a methodology  
by which you can play that 22. And I don't see a path  
or a desire on the part of the staff of doing that,  
certainly not yours -- because you're the one paying  
for it. But I see a need for that.

18 MR. WELTER: Well, just to reiterate, we  
19 do plan on developing a methodology and we're  
20 providing some preliminary results of that  
21 methodology. Staff will have an opportunity to audit  
22 that as downstream activities.

23 MEMBER MARCH-LEUBA: All right. We'll  
24 talk to the staff about their plans for that.

25 While I have the microphone and we're only

1       five minutes over, we have not talked about -- you  
2       don't seem concerned out of operational concerns. The  
3       fact that the flow is going to oscillate -- I will  
4       call it dramatically. I call it violently. You can  
5       it small. But it's a large flow space, okay, by any  
6       standard.

7                  You don't think that's an operational  
8       concern and your main argument -- let me apologize.  
9       Only Brian and Peter are going to understand what I'm  
10      going to say. The rest try to keep up. Your main  
11      argument is that the oscillations are going to be out  
12      of phase. And physics wants to do that because the  
13      left channel likes to borrow flow from the right  
14      channel because it doesn't cost any money in friction  
15      terms. And if you have to come from the pump, it  
16      costs friction, costs money. So it's cheaper to  
17      borrow money from the right than from the pump.

18                  However, that is in normal systems where  
19       the inlet flow restriction is not outrageously large.  
20       To borrow money from the right channel I have to go  
21       through the IFR, which is an outrageous friction. And  
22       therefore this fact that we all know that out-of-phase  
23       oscillations are preferred by nature over in-phase  
24       oscillations, I don't buy it in principle. You need  
25       to prove it.

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1 And we'll go into the; I keep saying  
2 classified, I mean proprietary, on the TF-2 design.  
3 I'd like to know what type of pump that we're using.  
4 Because with this flow -- you're following me, right?  
5 The flow restriction is not what we have in a BWR or  
6 a normal experiment -- It's infinite. To borrow flow  
7 from the right channel I have to pay a lot, whereas  
8 the interest from the pump might be less, especially  
9 when the flow control valve is fully open at 100  
10 percent power, and there is no friction there. And  
11 maybe at low flow when the valve is almost closed  
12 there will be a lot of friction and then the out-of-  
13 phase will be preferred.

14 So this blanket statement that is on the  
15 FSAR, and it went conducted on the SAR, that you don't  
16 have to worry about in-phase oscillations, I don't buy  
17 it. It's unproven.

18                           MR. WELTER: I understand and when we get  
19                           into the proprietary section, we'll talk about the  
20                           data and how we did not -- we observed out-of-phase  
21                           oscillations.

22 MEMBER MARCH-LEUBA: While we're waiting  
23 for that can you -- if Corvallis is listening, can you  
24 find out what that pump was the TF-2 experiment using  
25 and what type of flow, feedwater control --

1 MR. WELTER: Yes.

2 MEMBER MARCH-LEUBA: -- and you can tell  
3 us in an hour?

4 MR. WELTER: Sure. And we'll also talk --  
5 I'll talk more specifically about the type of feed reg  
6 valve we have in the plant, which is an anti-  
7 cavitation device, and the variable speed feedwater  
8 controller we have and provide some more detail on  
9 that for --

10 MEMBER MARCH-LEUBA: You have a variable  
11 speed feedwater --

12 MR. WELTER: Yes.

13 MEMBER MARCH-LEUBA: It used to be a  
14 valve.

15 MR. WELTER: Well, we have both. I'll  
16 talk about the feed reg valve and the feedwater pump  
17 and how we control it at the low powers and so forth.

18 PARTICIPANT: Yes, I think they need at  
19 the --

20 MEMBER MARCH-LEUBA: Yes, absolutely. But  
21 they keep telling us that my valve will do it.

22 CHAIR KIRCHNER: So we left off with Joe  
23 and Kevin.

24 Marty, are we pretty much through? You  
25 have one slide.

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1 MR. BRYAN: Yes, this is the last slide.  
2 We'll deal with the rest of it in the closed session.

3 So what we try to prepare is the process  
4 by which the successful completion of the ITAAC by the  
5 licensee constitutes the basis for NRC determination  
6 to allow operation of facilities certified under 10  
7 C.F.R. 52. So that's our conclusion. We'll talk more  
8 in the closed session of how we go about that.

9 Any other questions?

10 || CHAIR KIRCHNER: Go ahead, Pete.

11 MEMBER RICCARDELLA: Just to help me with  
12 my understanding. My understanding is that this  
13 density wave oscillation, if it occurs is only going  
14 to happen in certain regimes of operation, right?  
15 It's not a full-power thing. It's only as you go  
16 through a start-up or something.

17                   If it's occurring and if it's as violent  
18                   as Jose seems to think it's going to be, will the  
19                   operators know? Is there any indication that you'll  
20                   have to know that it's going on? Any instrumentation  
21                   or I don't know --

22 || PARTICIPANT: Noise.

23 MEMBER RICCARDELLA: Noise. Yes,  
24 vibration.

25 MR. WELTER: First off, I think it's not

as -- NuScale doesn't believe this is as violent as  
maybe others think, and we'll try and talk to that in  
the closed session, and that it doesn't really  
propagate beyond the feedwater plenum. And then our  
reg valve and our variable-speed feedwater pump can  
accommodate that.

In terms of instrumentation, we don't have any specific instrumentation currently in the plant that would detect DWO at a high level of confidence, if you will, that it's occurring or not, and frankly because from an operational perspective DWO is not really an issue based on the current design and the IFR concept. And in addition, if we show that we're under the fatigue limit, it's not a fatigue issue as well.

16 So we have considered it in our design.  
17 And remember our control system is not designed yet,  
18 but we need to take into consideration the presence of  
19 DWO in the development of our control system. But,  
20 yes, currently there is no specific instrumentation  
21 for monitoring or detecting DWO. And we haven't  
22 identified a need yet.

23 MEMBER RICCARDELLA: Well, part of  
24 defining what the fatigue cycles are going to be in  
25 the technical specification will be what percentage of

1       an operating cycle does it occur? Does it occur one  
2       day out of a year, or does it occur 50 percent of the  
3       time?

4                    MR. WELTER: And we'll get a little bit  
5       more in the closed session, but just if we show that  
6       it -- we can sustain an infinite number of cycles of  
7       a wide range of conditions, we wouldn't necessarily  
8       need to track those fatigue cycles. But if we said to  
9       meet some of these limits we needed to identify some  
10      of these cycles, then that would be potentially a  
11      different approach.

12                  MEMBER RICCARDELLA: I'm a little --

13                  MR. WELTER: Lead us down a different  
14      path.

15                  MEMBER RICCARDELLA: -- skeptical of  
16      endurance when it's --

17                  CHAIR KIRCHNER: Okay. Let me take the  
18      prerogative of chair and let's stop here, because we  
19      now several times have gone into material that I think  
20      we had expected to cover under closed session.

21                  So we need to change out. Thank you,  
22      NuScale and to the staff for the open session. And  
23      then I think at that point -- and we'll take a break  
24      after we hear from the staff and then we'll go into  
25      closed session.

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1 We're back in session and we're still on the  
2 record and I'm going to turn to Bruce Bavol of the  
3 staff.

5 MR. BAVOL: Thank you very much. My name  
6 is Bruce Bavol. I'm NRC staff with the Office of NRR.  
7 I'm also facilitating for -- this will be for Chapter  
8 5 review from the staff perspective and also Chapter  
9 3. I'm filling in for my colleague Mary Liz Johnson.

10                   This is the open session for steam  
11 generator. The slides that I provided to the members  
12 have what we call backup slides, and that will be  
13 several topics that we'll cover: flow-induced  
14 vibration, NRELAP steam generator modeling, and  
15 secondary wave oscillation. So hopefully we can  
16 answer your questions in the closed session also.

With that, to my right Yuken Wong and Greg  
Makar will be going over the Chapter 5 and Chapter 3  
parts of the review. And there were a couple of  
questions from the NuScale side that I'll sure they'll  
be able to answer for you.

So with that, I'll turn it over to Greg.

23                           And, Greg, just let me know when you need  
24                           to change slides.

25 MR. MAKAR: Thank you. My name is Greg

Makar. I'm a materials engineer with the Division of New and Renewed Licenses in the Corrosion and Steam Generator Branch. And as Bruce said, we have prepared material today that touches on different chapters and topics. Some of it is for open discussion; some if it will be closed discussion.

I'm going to begin with the type of material we review in Chapter 5 related to materials of the steam generator and the inspection program. Yuken's going to present some Chapter 3 items on the ASME Boiler and Pressure Vessel Code, stress calculations and flow-induced vibration. And then it will return to me and I'm going to touch on some -- the other topics of the stability topical report, secondary side density wave oscillation and accident analysis.

17 And we have other staff members here that can provide  
18 answers and present material in more detail than I  
19 can.

On this slide I just wanted to show -- I  
don't want to spend a lot of time on this, but I  
wanted to give a review of the kind of information  
that we review in Chapter 5. This is related to the  
selection of materials and the requirements for  
processing, code classification, water chemistry, and

then access for -- to inspect the steam generators on both sides. And our focus here on these topics is tube integrity; that is leakage and structural integrity of the tubes.

5 And so this -- and the inspection here is  
6 for progressive forms of degradation, rapid forms of  
7 degradation. The intent is to design -- is to address  
8 them in the design phase. And so something like flow-  
9 induced vibration is addressed in Chapter 3.

10 || Next slide, please, Bruce.

```
11             There are many similarities between these  
12 steam generator --
```

13 MEMBER MARCH-LEUBA: Sorry. You got me  
14 sleeping. The FSAR Section 5, I believe -- I read so  
15 many documents; correct if I'm wrong, it basically  
16 says you do not cover the secondary side instability  
17 in Chapter 5. It's covered in 15.9, correct? The  
18 AREVA --

19 (Simultaneous speaking.)

20 MR. MAKAR: Yes.

21 MEMBER MARCH-LEUBA: Okay. So you're not  
22 going to talk about density wave?

23 MR. MAKAR: I'll talk to that. I have  
24 some slides on that later.

25 MEMBER MARCH-LEUBA: But your SER does

1 not?

2 MR. MAKAR: The SER, Chapter 5 does not.

3 MEMBER MARCH-LEUBA: And then you refer to  
4 15.9, which doesn't either. Just for the record.

5 MR. MAKAR: There are a lot of  
6 similarities between these steam generators and the  
7 ones that are at operating plants. I want to point  
8 out some of the differences that we're familiar with  
9 mainly so that I can then point out how they affected  
10 our review.

11 One is the primary pressure outside the  
12 tube, so the tendency is more for a collapse than a  
13 burst of the tube. There's the helical coil shape.  
14 The first of a kind flow restrictors, support  
15 structures and steam and feed plenums. And first of  
16 a kind means developing the appropriate design and  
17 inspection requirements.

18 Next slide, please, Bruce.

19 And these are how these differences affect  
20 our design B. All plants are required to perform a  
21 degradation assessment to assess what types of  
22 degradation they expect to find in the steam  
23 generator. This would be different than the operating  
24 fleet. A big difference is that they are looking at  
25 tube collapse rather than tube burst as the primary

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1 failure mode.

2                   There are also maybe secondary -- effects  
3 of the secondary coolant on steam generators that we  
4 haven't seen in others because we now have the less-  
5 pure water inside the tubes rather than on the  
6 outside. There may be some beneficial effects of  
7 having it arranged that way, but there may be things  
8 like deposits that form in the tubes that affect  
9 inspections in a way that they don't in operating  
10 reactors now.

11                  There are new flow effects and loose parts  
12 potential inside and outside the tubes because we have  
13 different types of support structures. We have flow  
14 restrictors inside the tubes. And the inspection  
15 methods require development because of the different  
16 tube shape and potentially internal deposits which can  
17 affect the -- both the ability to inspect and  
18 potentially the results as well.

19                  And these inspection analyses require  
20 qualification as well as developing the procedures to  
21 do it. They're going to have to be qualified to show  
22 that they are -- that they do what they intend. And  
23 so there may be things like cleaning the insides of  
24 the tubes that may -- could be required that we don't  
25 -- that plants don't worry about now.

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1 There's also the question of inspection  
2 interval. All tubes will be -- 100 percent of the  
3 tubes will be inspected after the first operating  
4 cycle. After then we have performance-based tech  
5 specs which NuScale is adopting which -- where the  
6 subsequent inspection would be determined by the  
7 results of the first operating --

8 (Simultaneous speaking.)

9 MEMBER MARCH-LEUBA: Out of curiosity the  
10 100 percent inspection is for the first module or for  
11 each of the --

12 || (Simultaneous speaking.)

13 MR. MAKAR: Every steam generator tube.

14 MEMBER MARCH-LEUBA: Every single one?

15 MR. MAKAR: Yes.

16 MEMBER REMPE: So I have a question about  
17 this, too. It seems from the discussions even earlier  
18 today that there's some information that's going to  
19 come as we gain operating experience, and clearly  
20 NuScale has to do some investigations. What about the  
21 staff? Is research needed by the staff or is your  
22 approach going to be just stand off and look and see  
23 what the folks from NuScale, or whoever the COL  
24 applicant is, learns? Do you need to have some sort  
25 of user need to research to have them get engaged to

1 help you define what parameters should be the ones  
2 that you're going to focus on, or what's your plan of  
3 attack to close this out?

4 MR. MAKAR: We have included an item on  
5 inspection of these steam generators in our  
6 discussion, and I have to be honest, I don't remember  
7 what we included, what's included in a user need  
8 for --

9 (Simultaneous speaking.)

10 MEMBER REMPE: Well, when we talked to the  
11 folks from research about it, which was several months  
12 ago, they said, no, we've not seen anything coming  
13 from the folks that are reviewing the NuScale reactor.  
14 And so you think you've got enough? You don't need to  
15 do anything else? Do you think maybe this might be  
16 something where it would be good to have some sort of  
17 research effort engaged in it?

18 MR. MAKAR: I think it would be  
19 supplemental in the sense that when they do  
20 inspections and have their condition monitoring and  
21 operational assessments to look at what's going  
22 forward, it's going to be based on the information  
23 available from their steam generators and operational  
24 experience from other steam generators as best that  
25 can be --

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(Simultaneous speaking.)

2 MEMBER REMPE: So I'm going to paraphrase  
3 your response is that the Agency can basically dictate  
4 what the COL applicant needs to provide and then we'll  
5 decide. You're basically saying, no, I don't think  
6 the Agency should be spending research dollars on it.  
7 Is that what I'm hearing from you? I'm just trying to  
8 -- understand what your response is.

11 MEMBER REMPE: Okay.

12 MR. MAKAR: And again, I think we also  
13 have had discussions about what we might need for  
14 this, what we might want to supplement our reviews on  
15 this.

16 MEMBER REMPE: But you think that the --

17 MR. MAKAR: So I don't think -- I think we  
18 haven't determined that it's necessary.

19 MEMBER REMPE: Okay. You're going to make  
20 the COL applicant pay for it? You're not thinking  
21 that the --

22 || MR. MAKAR: We're not --

23 MEMBER REMPE: -- research dollars are  
24 needed to do it?

MEMBER MARCH-LIEUBA: But following on

1 that, I mean right now you, Greg; and I'm going to use  
2 you as an example of all of the staff, you are the  
3 number one expert on what areas of this design were on  
4 more certainty, where we would benefit from additional  
5 research. It would be worthwhile if you guys have a  
6 half a day off-site meeting and bring the map and pass  
7 them to management and say, okay, if you are going to  
8 spend research dollars, I would like you to spend  
9 research dollars on fretting on the steam generator.  
10 That would be worthwhile. That would have value for  
11 me. Yes, and if you get together, you're going to go  
12 out with 100 topics, okay, because everybody has a  
13 favorite one.

14                   But right now you guys are the number one  
15                   expert in the world on what assumptions you have to  
16                   make where data would have been valuable. And before  
17                   you forget, it would be really worthwhile to get  
18                   together and then let management decide whether they  
19                   have the money.

20 MEMBER REMPE: And as I recall what Dennis  
21 was saying earlier, there were a lot of lessons  
22 learned over the years with the traditional steam  
23 generators. We didn't have all the answers. And it  
24 might be good to get ahead of it.

25 MR. MAKAR: Okay.

1 MEMBER REMPE: But that's just one  
2 member's opinion.

3 MR. MAKAR: Thank you. Whatever we have  
4 decided or have -- maybe haven't decided yet about  
5 user need research, we also have National Lab people  
6 available who support us in steam generator work as  
7 well, data analysis and testing.

8 MEMBER MARCH-LEUBA: And don't concentrate  
9 only on the steam generator. Think about pumps,  
10 amount of circulation, boiling. I mean what would you  
11 have liked to have more data to complete this review,  
12 and just have a list. That's a recommendation from  
13 one particular member.

14 MEMBER BLEY: I want to take you back to  
15 the tech specs you mentioned. They require 100  
16 percent testing the first time around and then it's  
17 based on the results. Those requirements came out of  
18 following the U-tube steam generators for 50, 60 years  
19 as it evolved. Given that these are completely new,  
20 are the requirements applicable or does something more  
21 aggressive need to be considered? Have you thought  
22 about that?

23 MR. MAKAR: Some of requirements that are  
24 not -- that are associated with the tech specs, the  
25 guidelines are still applicable and fairly clear about

1 how to say take your inspection results and assess  
2 going forward when you need to inspect next. The  
3 difficulty for a new design like this is they -- that  
4 requires things like what is -- if there is some wear  
5 of the tubes, what wear rate is going to be assumed  
6 for the next cycle? And in most cases for operating  
7 plants they can use values that they -- we agree are  
8 conservative --

9 MEMBER BLEY: You've got pretty good  
10 expectations for that.

11 MR. MAKAR: -- and they can still get  
12 through the next cycle or more.

13 In this case I think it's going to require  
14 conservative assumptions until they have more data.  
15 So that's --

16 (Simultaneous speaking.)

17 MEMBER BLEY: Is that something that can  
18 happen within the current tech spec, or do you need to  
19 look for a change?

20 MR. MAKAR: Right. The current tech specs  
21 and framework that they're using will require them to  
22 do that kind of assessment. We inspect at the plan  
23 the work they're doing during the outage. And they  
24 also submit the reports to us as part of the tech  
25 specs. And then we ask questions about the findings

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1 and the decisions they make. So that's something that  
2 would have to be -- whatever decisions they make about  
3 the next cycle is something we can question.

4 MEMBER BLEY: Okay. Thanks. I opened  
5 this and that leads me to another place where I didn't  
6 really have a disagreement with Jose earlier, but I  
7 had said we had pushed for things to be moved forward  
8 in other design certs and cited the IEEE requirements  
9 that have reports that get done as ITAAC, but those  
10 have methodologies that the staff has already  
11 approved. From what we were hearing this methodology  
12 is evolving. And I don't know, the argument that  
13 there ought to be a topical report kind of makes sense  
14 to me.

15 Have you guys thought about that aspect?  
16 How do you look at this methodology? You just go down  
17 and do a -- the audits may or may not dig deep enough  
18 to find problems. I mean it's an interesting issue.

19 MEMBER MARCH-LEUBA: And let's look at  
20 human nature. If we wait to review the ITAAC after  
21 they've done all the work, the only option you have is  
22 to review it, to approve it. You're not going to  
23 reject it. So the time to agree on the methodology is  
24 before they spend all the money to do the calculation.

25 MR. MAKAR: We've had that discussion.

1 Some questions have been asked by other members of the  
2 staff. I think this ITAAC gives us the ability to dig  
3 down and do whatever review we need to do on this, but  
4 it's a -- but how long is that going to take, at what  
5 point in the process? And it's not defined.

6 MEMBER MARCH-LEUBA: And it's reasonable  
7 that the data is going to go to a region somewhere.  
8 And then we have a poor lonely mechanical engineers  
9 saying does it satisfy us, anyone? Yes, yes, yes,  
10 yes. Done. Well, it won't come back to you.

11 MR. MAKAR: I think we are able --

12 MEMBER MARCH-LEUBA: You are able to,  
13 but --

14 MR. MAKAR: -- to do that if we --

15 MEMBER MARCH-LEUBA: -- the default, it  
16 goes to a lonely mechanical engineer in a region.

17 MR. MAKAR: But it's an area of  
18 uncertainty and therefore schedule risk.

19 MEMBER BALLINGER: Again, what you've I  
20 think adequately described is this competition that's  
21 been going on the steam generator, and that -- the  
22 earlier steam generator designs we learned by painful  
23 experience. And so we've evolved to using Alloy 690.  
24 That took is a while. But that was presuming certain  
25 degradation mechanisms that we were finding a solution

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1 for, which we did. And that's the other -- on the  
2 other side you've got a steam generator that's very  
3 new in this design. It's using 690, which is a great  
4 material, but you got to be careful that the  
5 inspection interval initially -- the initial  
6 inspection interval is cognizant of the fact that  
7 there may be something going on that we didn't account  
8 for or find in the U-tube type or recirculating steam  
9 generators.

10 MEMBER BLEY: We solved them eventually,  
11 but --

12 MEMBER BALLINGER: Yes, but --

13 MEMBER BLEY: -- we had plants that were  
14 never -- I mean we didn't even have a way to get the  
15 steam generators tubes out. We had to cut holes in  
16 the --

17 MEMBER BALLINGER: Yes, well, I think  
18 that --

19 MEMBER BLEY: -- containment to get things  
20 out and replace them. It was a big deal.

21 MEMBER BALLINGER: I don't think it's 100  
22 percent, but it's darn close to 100 percent of initial  
23 steam generators did not make it past 20 years. They  
24 had to be replaced.

25 MR. MAKAR: We agree completely that the

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1 degradation assessment for a plant like this is  
2 different based on the material and design factors,  
3 and that was the nature of a lot of our discussions  
4 with the applicant.

5 And so just the status of our review in  
6 this area is that we -- there are some confirmatory  
7 items to clarify language. And as you also heard from  
8 the applicant, there is -- they are looking at the  
9 language in Chapter 5 about some of the statements  
10 that were made, and they made some changes. I think  
11 we will have some corresponding changes to make in our  
12 SER.

13 MEMBER MARCH-LEUBA: Are you planning to  
14 add some confirmatory items related to the methodology  
15 for DWO?

16 MR. MAKAR: Currently we do not.

17 MEMBER MARCH-LEUBA: You don't plan to?

18 MR. MAKAR: We don't plan to.

19 MEMBER MARCH-LEUBA: Then do you know of  
20 any steam generator in the world that operates in --  
21 stable condition?

22 MR. MAKAR: No.

23 MEMBER MARCH-LEUBA: That's an unusual  
24 circumstance. I think it certainly deserves a little  
25 more inspection.

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1                   MR. MAKAR: Well, to address the stability  
2 issue that -- I don't think a -- we wouldn't have a  
3 confirmatory item now because there's nothing to  
4 confirm. It's more of the methodology and the --

5                   MEMBER MARCH-LEUBA: But we're going back  
6 to the topical --

7                   MR. MAKAR: Yes.

8                   MEMBER MARCH-LEUBA: -- the need for a  
9 topical report. Call it technical report. Call it an  
10 off-site meeting. But there is a need to agree on  
11 what methodology we'll use before you send me that  
12 final number.

13                  MR. MAKAR: So we agree that this is not  
14 resolved. It's -- rather than a confirmatory item,  
15 it's another regulatory process.

16                  MEMBER MARCH-LEUBA: Talk to the lawyers  
17 and figure out how to do it, but it needs to be done.

18                  MR. MAKAR: Next slide, please, Bruce.

19                  Well, we've talked a lot about the  
20 inspection already, so I'll just reiterate that this  
21 is -- that they are adopting a mature -- framework  
22 would have been a better word here than program. We  
23 think of program as the individual plant's inspection  
24 program. But this combination of the NEI 97-06  
25 program with the research guidelines and technical

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1       specifications has requirements on -- which define  
2       structural and leakage integrity and the required --  
3       it requires that they do inspection and operational  
4       assessment and condition monitoring.

5                 And as we said, it will include the full  
6       length of the tube and for -- during each inspection  
7       the full length of the test -- we have to inspect the  
8       full length of the tube with a technique that can find  
9       what they're looking for, and the objective is to find  
10      any kind of degradation from one tube end to the  
11      other.

12               The tech specs also have limits on primary  
13      and secondary leakage, and it serves as the ASME Code  
14      inspection on the tubes and it limits the allowable  
15      through-wall degradation. As we said, the first  
16      outage is going to be 100 percent of all of the tubes  
17      and that these inspection reports are submitted to the  
18      staff.

19               Next, please, Bruce.

20               Now I just wanted to go into a little more  
21      about how the inspections are done. So the plant is  
22      to do what -- operating plants do it in spectrum. The  
23      tube -- look for tube degradation by putting eddy  
24      current probes inside the tubes that look for  
25      volumetric degradation that could be on the inside or

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outside of the tube and internal or external cracking.

Most of this applies to NuScale with some modifications. Like operating plants, they are using eddy current testing.

In general plants have found that they can manage wear from support structures and foreign objects over time. It depends on the nature of the cause and the type of characterization they're able to do with the eddy current and also the projected growth rate.

Cracks generally are plugged when they're detected. There are some exceptions that some plants have through license amendments. And then there's a -- on the shell side there is a visual inspection to look for things like loose parts, foreign objects, deposits and things of that nature. And the NuScale program is described in the FSAR. There's a COL item for the -- to actually submit the program.

19 MEMBER MARCH-LEUBA: Are there any  
20 requirements with respect to loose parts? Because  
21 keeping the primary system clean is very -- not very  
22 easy, but it's doable. Now keeping the secondary side  
23 where it's all balance of plant -- or all those  
24 things, keeping that clean us much harder. And that's  
25 why BWRs have problems and PWRs don't typically have

1 that many problems.

2                   Any flake of oxide that comes off from the  
3 -- pack will stuck into the IFRs and will produce  
4 additional loads, flow restrictions. Any fiber; that  
5 clearance is one of my hairs, and I have very thing  
6 hair, you're the same thing, will block it. Okay? So  
7 has there been any effort to minimize loose parts on  
8 the secondary?

9                   MR. MAKAR: I don't know what all they do  
10 to minimize loose parts on the secondary. I think in  
11 some -- I can't say. What I can say is that from an  
12 inspection standpoint there -- you would -- if you  
13 have something, you would assess whether it's --

14                   MEMBER MARCH-LEUBA: My experience is --

15                   MR. MAKAR: -- what the consequences are,  
16 whether it's okay to leave it there, if you remove it,  
17 where it came from and what you need to do to prevent  
18 it from happening again.

19                   MEMBER MARCH-LEUBA: We're talking about  
20 a piece of hair. I mean it's minimal. You can hardly  
21 see it. My experience with BWRs that most of the fuel  
22 leakage, the failure, the clad failure is because a  
23 small loose part that sticks into the spacer. And  
24 here we have a filter, which is the inlet on the steam  
25 generator that will catch every loose part that's

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1 small enough to fit inside, which are the EC1 steam  
2 generator because they're the small ones.

3 And whenever you have one of those in BWR,  
4 you fail the claim, because the conditions are  
5 different and much more severe than here. But the  
6 potential is there. I mean you have the mechanism to  
7 trap every single flake of oxide that moves to the  
8 secondary, and this is the balance of plant model.

9 MR. MAKAR: That may not make it to  
10 inspection, so that would affect operation and --

11 MEMBER MARCH-LEUBA: It would if it breaks  
12 a tube.

13 MEMBER DIMITRIJEVIC: Well, I have a  
14 fundamental question related to Chapter 19. What is  
15 the failure mode we are most concerned here? Because  
16 we are not talking to burst, but to collapse. So is  
17 that going to result in the leakage or rupture? What  
18 is our -- because I notice they don't say steam  
19 generator tube rupture in PRA. They say steam  
20 generator tube failure.

21 MR. MAKAR: That's right.

22 MEMBER DIMITRIJEVIC: What's a failure  
23 mode?

24 MR. MAKAR: Failure mode is -- in the  
25 primary mode is collapse and we don't --

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1 MEMBER DIMITRIJEVIC: So what, like a  
2 plugged tube, a vacuum tube or rupture tube or --

3 MR. MAKAR: We wouldn't necessarily --  
4 there would not necessarily be primary/secondary  
5 leakage in --

6 MEMBER DIMITRIJEVIC: Right.

7 MR. MAKAR: -- this mode of failure, but  
8 we don't know. So when we look at the tube plugging  
9 criterion, for example, how thin can the tube get  
10 before it would collapse? We are approaching that  
11 with preventing collapse.

12 MEMBER DIMITRIJEVIC: So from the safety  
13 point of view is our main concern losing effectiveness  
14 or is our main concern leakage within  
15 primary/secondary? What is the main concern?

16 MR. MAKAR: For safety it would still be  
17 leakage because we don't know if there would be a  
18 rupture or a break in the tube during a collapse.

19 MEMBER DIMITRIJEVIC: So leakage is still  
20 our main safety concern?

21 MR. MAKAR: Right.

22 MEMBER DIMITRIJEVIC: All right.

23 MEMBER BALLINGER: With respect to the  
24 visual inspection with a U-tube steam generator you  
25 have limited inspection visual capability, but you do

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1 have a tube lane. You go inside, you can do the  
2 outside, but in this steam generator how much of the  
3 system can you actually see with a visual inspection?  
4 It sounds to me that it's pretty limited.

5 MR. MAKAR: Very. I can't --

6 (Simultaneous speaking.)

7 MEMBER BALLINGER: Very limited, yes.

8 MR. MAKAR: But you would have access to  
9 the tightest spins and the -- be able to see the --

10 MEMBER BALLINGER: The tightest spins?

11 MR. MAKAR: Yes, which are the -- yes,  
12 because they're at the top and the bottom. And things  
13 that are going on at the tube sheet. And some ability  
14 to see the support structures. And tabs, looking for  
15 the condition of tabs and spacers.

16 MEMBER BALLINGER: Which is the outside?

17 MR. MAKAR: Right. And I should mention  
18 also that the steam generator supports, which are the  
19 horizontal bars that are welded to the reactor vessel,  
20 since they're -- that's a Class 1 weld, so that has an  
21 ASME Code requirement for those welds, I assume.

22 But that's all I had for Chapter 5, and so  
23 I'll -- Yuken will now present Chapter 3.

24 MR. WONG: Thanks. My name is Yuken Wong  
25 from the Mechanical Engineering and -- Testing Branch.

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1 I've reviewed the reactor internals vibration program  
2 with assistance from Dr. Steve Hanbric. He's on the  
3 phone. I will present the flow-induced vibration  
4 review and the ASME Section 3 stress analysis area.

5 Dr. Steve Hambric and I have previously  
6 presented the review of the steam generator vibration  
7 evaluation and the TF-3 testing audit. The review  
8 involved the flow-induced vibration, fatigue  
9 evaluation and wear for the flow-induced vibration  
10 mechanism involving vortex shedding, fluidelastic  
11 instability and turbulence buffering.

12 NuScale has updated the analysis based on  
13 the mode of testing from the TF-3 specimen. The  
14 margins have improved. The staff reviewed the  
15 analysis and the margins and they are acceptable.

16 In the interim letter the ACRS recommended  
17 some Tier 1 commitment such as ITAAC for the  
18 completion of the TF-3 test, and NuScale has included  
19 the TF-3 statements in Tier 1 of the FSAR and also  
20 Tier 2 in Section 14.2 regarding initial start  
21 testing. The test acceptance criteria are also  
22 included. The staff finds the description and  
23 acceptance criterias are acceptable.

24 Next slide. The inlet flow restrictor is  
25 susceptible to liquid flow instability and the design

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1       is evaluated by testing. The three concept designs  
2       are tested and one of the design is selected, and it  
3       has adequate margins against flow-induced vibration as  
4       well as adequate pressure drop.

5                    MEMBER MARCH-LEUBA: While you have this  
6       here, the argument that was making earlier this  
7       morning -- first, I'd like the arguments, I love this.  
8       First, look at the device. There is a Christmas tree.  
9       You have couple hundred, three hundred IFRs protruding  
10      from this plate and each of them is occluding from the  
11      back of the plate. So it's cantilever on the plate.  
12      And somebody, a robot or a person, will grab it and  
13      will try to align each of those things into the steam  
14      tubes, all of them at once.

15                  I know I've tried to do that. I mean I  
16      was replacing some door handles and I couldn't put the  
17      screw in the right hole this weekend. Putting 300 of  
18      them in the right hole is going to be very difficult.  
19      And you are going to end up scratching the tube or the  
20      IFR therefore increasing the clearance, the gap. Over  
21      80 years, 60 years of operation that gap is going to  
22      be twice as big after you've taken it and put it back  
23      100 times. That's number one.

24                  Number two, whenever you have reverse flow  
25      with high void fracture, it's not just reverse flow.

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1 It's reverse flow at 10, 20, 40 times a velocity that  
2 is normal and with a dynamic load consistent with  
3 cavitation. You have voids and liquid and an uneven  
4 force. So it's -- basically the thing is cavitated.  
5 Plus, when it comes out, it's impinging on the plate  
6 at this high velocity.

I would not want to have to analyze the  
mechanical integrity of that plate and those devices  
myself, number one. I couldn't do it for a single  
cylinder myself. But I don't think Pete can analyze  
the mechanical integrity of that thing under those  
conditions. Hopefully we have a lot of margin, but to  
me it seems that this reverse flow with high void  
fraction at a tremendously high speed; and I'm  
surprised it not choke flow, does not produce  
vibrations -- Okay. Yes, and now that you have  
visualize it, you see the --

18 MEMBER BLEY: If you really have two-phase  
19 conditions coming in, we got to get steam cutting,  
20 too, I would expect on these things. Yes.

21 MEMBER MARCH-LEUBA: Yes, I -- if I was  
22 going to do this in trace, I would put a K factor and  
23 a frequent factor, an effective frequent factor  
24 forward and an effective frequent factor backward and  
25 do the analysis like that. That's not what's

1 happening. What's happening is in each of those you  
2 have an acceleration, a deceleration. Voids are going  
3 randomly producing uneven dynamic loads. And true the  
4 rod is pretty stiff, but it's held by a single screw  
5 at the bend at the end and it's been there for 60  
6 years. I'm not convinced that that thing doesn't  
7 vibrate and produce fretting.

8                   And basically my concern from the point of  
9 view of stability, which is my concern, is that the  
10 IFR is going to lose its effectiveness with time and  
11 the gap will be larger with time. I mean you're going  
12 to relax. One way or another it's going to relax and  
13 instead being a friction factor of 100, it will be 90  
14 or 80 or 60 or 40, and therefore it will become more  
15 and more unstable at full power. Just wanted to put  
16 this in the open record.

17                  MR. WONG: Okay. We will discuss more in  
18 the -- regarding reverse flow in the void fraction  
19 later on in the closed section.

20                  And regarding the scratching on the side  
21 of the wall due to the installation for the hundreds  
22 of IFRs, in the test for the concept design they did  
23 have misalignment tests that have the FORs in IFRs  
24 touching the side of the tube. And they performed the  
25 bore scope inspection and find the wear is acceptable.

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1 MEMBER MARCH-LEUBA: What inspection they  
2 perform?

3 MR. WONG: They inspected the inside of  
4 the tube after the test and they found the wear is  
5 acceptable.

6 MEMBER MARCH-LEUBA: And this test had  
7 reverse two-phase flow on it?

8 MR. WONG: I do not --

9 MR. HAMBRIC: This is Steve Hambric. No,  
10 it did not.

11 MEMBER MARCH-LEUBA: I didn't want to  
12 offer the answer for you guys because you always tell  
13 me I'm wrong, but I was 99.9 percent sure that they  
14 didn't. Okay.

15 MR. WONG: Okay. From the -- the concept  
16 is -- concept testing, NuScale selected the final  
17 design for the IFR and the final design is similar to  
18 one of the tests that the -- tested design, and this  
19 testing, this final design will be validated by a test  
20 and this test will be performed after design  
21 certification. The test plan and acceptance criteria  
22 are described in the NuScale technical report and the  
23 staff finds the description and acceptance criteria  
24 reasonable.

25 MEMBER BLEY: What does it mean that

1       they'll be similar to the ones that were tested? How  
2       will they be different?

3                    MR. WONG: They are all -- they are step  
4       design with five different steps, as you see on the  
5       sketch. And the step length is within 10 percent.  
6       The spacing between the steps is also within 10  
7       percent. And also there's a tip at the end of the  
8       inlet flow restrictor. That length is also within 10  
9       percent.

10                  MEMBER BLEY: But they changed it as a  
11      result of the test? I'm curious as to why it's not  
12      exactly like the ones they tested.

13                  MR. WONG: I don't recall the specific  
14      reasons. I cannot answer the question.

15                  MEMBER BLEY: So it's almost the same?  
16      And just before we try to start this up we'll get some  
17      confirmation that it's okay?

18                  MR. HAMBRIC: Yes, that's correct.

19                  MR. WONG: Yes, the test will be  
20      performed --

21                  MEMBER BLEY: Thank you, Steve.

22                  MR. WONG: -- prior to initial start  
23      testing. And that is a part of the -- completing the  
24      comprehensive vibration assessment program.

25                  MEMBER RICCARDELLA: And that is covered

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1 by an ITAAC?

2 MR. WONG: It's covered by the Chapter  
3 14.2 initial start testing activities.

4 MEMBER RICCARDELLA: Okay.

5 MR. WONG: Even though it's performed in  
6 a lab, but it's covered in the FSAR.

7 MEMBER BALLINGER: A little bit of a  
8 nitpick on this slide. Alloy 690 is not a nickel-  
9 chrome-iridium alloy.

10 MR. WONG: Thank you.

11 MEMBER BALLINGER: That would be kind of  
12 cool, but --

13 MR. HAMBRIC: That's my fault. I should  
14 have -- Apologies.

15 MR. WONG: Okay. Density wave oscillation  
16 was observed in the TF-2 testing. The test data  
17 showed a temperature and secondary flow oscillation.  
18 train gauges was installed on the tubes and the test  
19 data indicate long oscillation periods. So the  
20 oscillation frequencies and the steam generator tube  
21 resonance frequencies differ by an order of two  
22 magnitude, so the density wave oscillations would not  
23 excite the steam generator tube resonance frequencies.

24 MEMBER MARCH-LEUBA: Yes, but -- I'm not  
25 a mechanical engineer, but in my mind clearly the

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1 limiting case is where you weld the tube to the plate,  
2 not the middle of the tube. So it's the connection of  
3 the tube to the inlet plate is where you want the  
4 strain. That would be the limiting case, wouldn't you  
5 agree? So in the middle of the tube -- those tubes  
6 are strong. That's not going to be a problem. It's  
7 going to be the welding.

8 MEMBER RICCARDELLA: It's going to be a  
9 fatigue problem. It will be a discontinuity, not in  
10 the middle of a tube like that.

11 MEMBER MARCH-LEUBA: And these  
12 measurements will depend a lot of how prototypically  
13 they clamp the tubes with those three --- elements.  
14 So if you let them flex, if you have it relaxed, it  
15 will stand and there won't be any strain. If you have  
16 one that is more clamped, it will -- so, yes. It's  
17 good that we have an example that it wasn't bad, but  
18 I don't think it's limiting.

19 MR. WONG: Yes, the steam generator tube  
20 as well as the welds will be evaluated according to  
21 the ASME Section 3 requirement according to the ITAAC.

22 There are strain gauges mounted on the  
23 outside of the tubes and using the strain gauge  
24 measurements they are in the order of hundreds of  
25 microstrain. So the staff evaluated alternating

1 stress intensities and found the alternating stress  
2 intensities below the endurance limit.

3 The maximum surface stress are below the  
4 tube yield and ultimate strength. And we know that  
5 the TF-2 test is not identical to the MP operating  
6 conditions, so NuScale will perform the ASME stress  
7 evaluations as required by the ITAAC to confirm this  
8 preliminary stress analysis.

9 MEMBER PETTI: So was the calculation done  
10 -- is it done for the free tube or was it done where  
11 there's constraint? I can see that there's not a  
12 problem where the tube was allowed to move, but was  
13 the calculation done either at the -- where it's  
14 welded or where it's clamped, where there's --

15 MR. WONG: We have not seen --

16 MR. HAMBRIC: This is Steve Hambric. Yes,  
17 we're just taking the measured surface strains as  
18 implemented. It's not really an analysis. We take  
19 the strains and multiply it by e. That's pretty much  
20 it. So it's a measurement of the strain. And I agree  
21 that the welds are probably more important, but we  
22 don't have access to that information, and as Yuken  
23 said, that should be part of the upcoming ASME  
24 calculations under the ITAAC. They should do the  
25 assessments of the stress at any welds.

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1 MEMBER PETTI: Okay. Thank you.

2 MR. WONG: Okay. Next slide, please. The  
3 oscillating thermal loads can cause the tubing to  
4 expand and contract. Because of the long oscillating  
5 periods, this should not cause vibration, but it cause  
6 the tube to slide along the tube supports. And you  
7 can see the sketch on the lower right. The thickness  
8 of the tube support is much bigger than the thickness  
9 of the tube. So the tube supports should experience  
10 even lower stresses. And as Greg had indicated  
11 earlier, the long-term wear of the tubes will be  
12 monitored by the steam generator inspection programs.

13 Next slide, please. Okay. Regarding the  
14 ASME Section 3 stress analysis, the steam generator  
15 tubes are ASME Class 1. ASME Section 3 Code requires  
16 the analysis to address fatigue and the relevant  
17 design loads. And there's an ITAAC to require NuScale  
18 to perform the ASME Section 3 analysis. And for the  
19 Class 1 component is listed in DCD Tier 1 table 2.1-2.  
20 And the steam generator is listed as one of the  
21 components in that table.

22 MEMBER BALLINGER: We keep going round and  
23 round about Section 3 and Class 1 and all that stuff.  
24 Has anybody on the staff taken a look at FFS-1? Which  
25 is fitness for service, and it's an ASME Code. And

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1 it's a recent; not so recent now I guess, adaptation  
2 of API-579 for the petrochemical industry. And it  
3 explicitly deals with environmental effects, corrosion  
4 issues, which the Section 3 doesn't. Just a thought.  
5 It's only 1,100 or 1,200 pages. You can read it in an  
6 afternoon, right?

7 MR. WONG: There's no reference to that.

8 MEMBER BALLINGER: No, I'm just -- no,  
9 there will -- eventually it will fold its way in. The  
10 Code operates on a geotechnical time scale.

11 PARTICIPANT: Geological.

12 MEMBER BALLINGER: Geological time scale.  
13 Excuse me. Maybe both.

14 MR. WONG: Thanks.

15 Okay. During initial start testing one  
16 tube in the steam generator will be instrumented with  
17 strain gauges. If density wave oscillation occurs,  
18 the strain gauges will be able to measure the change  
19 in strain in the tube. However, the strain gauge  
20 measurement is not intended to detect density wave  
21 oscillation because strain gauges in multiple tubes is  
22 needed -- are needed to detect the relative phase  
23 between the same two tubes.

24 So as I mention earlier, the steam  
25 generator tubes are qualified by the ASME stress

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1 analysis, the ITAAC requirement.

2 MEMBER MARCH-LEUBA: Since you're talking  
3 about instrumentation, the issue was brought earlier  
4 that we don't want to require any instrumentation to  
5 take DWO on this reactor. And it sounds unwise to me.  
6 Clearly operation in -- under unstable conditions is  
7 undesirable. Everybody will agree that this is  
8 undesirable. It may be tolerable from a strain  
9 position, but certainly undesirable.

10 And we expect -- and I'm siding with  
11 NuScale's evaluation that full power it's likely going  
12 to be stable.

13 Sorry, Pete.

14 I would still like to see the analysis.  
15 But I am also postulating that the IFR effectiveness  
16 is going to age. You're going to have binding, you're  
17 going to have movement, you're going to have  
18 misalignments, and 10 percent of the tubes will have  
19 an IFR that is not as effective as it should be --  
20 full power operation eventually. Okay? And there's  
21 this likelihood that it will do. And we don't need  
22 strain gauges on every tube -- I know that the theory  
23 will tell you --

24 CHAIR KIRCHNER: Just pardon the  
25 interruption. Someone on the line, would you mute

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1 your phone? We're hearing your paperwork scratching  
2 against something. We're picking up static.

3 MEMBER MARCH-LEUBA: It's static. Okay.  
4 We'll go over it. I'll talk louder.

5 So I know the theory tells you that the  
6 inlet and outlet pressure are constant during these  
7 out of phase oscillations, but they're not. So if the  
8 oscillations developed, the inlet and outlet pressure  
9 of the plenum will have one to 10 hertz -- 0.1 to 1  
10 hertz oscillations depending on the flow and will be  
11 detectable with simple instrumentation.

12 And if we are going to go into allowing  
13 unstable operation, which is an undesirable condition,  
14 and we do that because we believe that during normal  
15 operation it won't happen, but with respect that  
16 degradation of the IFR will get you there in 10 years,  
17 we should be monitoring it. Because if we start  
18 detecting significant noise on the inlet or the outlet  
19 pressures, we can do something about it. We can fix  
20 the IFRs. I mean we know that in this outage we need  
21 to align them or tune them, or whatever you need to do  
22 to make them work. So the fact that we don't have  
23 instability instrumentation, I consider that  
24 negligent.

25 And I realize that it's not your area of

1 expertise, but I don't know whose area of expertise it  
2 is? Who will require that? This agency is moving  
3 away from defense-in-depth and just risk-informed  
4 regulation. This is where defense-in-depth would be  
5 very helpful. I mean you say you're not unstable.  
6 Prove it. And we suspect -- I mean everything  
7 relaxes. Those IFRs are going to relax. They're  
8 going to degrade. I guarantee it. Will they degrade  
9 one percent or 100 percent? I don't know.

10 MR. WONG: Okay. Next one. This is a  
11 summary slide. I talk about the ITAAC for the ASME,  
12 the commitment to perform the TF-3 test commitment in  
13 the DCA. The density wave oscillation does not induce  
14 significant steam generator tube vibration. The ITAAC  
15 to perform the ASME Section 3 analysis and also the  
16 steam generator tube inlet flow restrictor testing  
17 will confirm the IFR final design.

18 And that's the end of my presentation.  
19 I'm going to turn it back over to Greg.

20 CHAIR KIRCHNER: Before we turn it over to  
21 someone else, Yuken, let me ask you a question on the  
22 second bullet. You say density wave oscillation does  
23 not induce significant steam generator vibration.  
24 What is that based on? Just a single tube or -- what  
25 we have, as Jose has outlined some scenarios,

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1 significant instabilities in multiple tubes? Is that  
2 going to lead to a vibration issue for the steam  
3 generator and hence --

4 MR. WONG: No significant vibration is  
5 because the differences in frequency, the DW frequency  
6 versus the steam generator --

7 (Simultaneous speaking.)

8 CHAIR KIRCHNER: No, I understand that.  
9 Yes, that's kind of a static analysis. I misspoke.  
10 Not static, but you're just looking at the fundamental  
11 structural resonant frequency?

12 MR. WONG: Right. And we don't believe it  
13 cause vibration. It will cause the -- there's a  
14 sliding of the tubes along the supports. And the --  
15 we have not seen the wear analysis from NuScale and  
16 this --

17 CHAIR KIRCHNER: Okay.

18 MR. MAKAR: -- the long-term wear due to  
19 this -- the slow oscillation will be monitored by the  
20 steam generator inspection program.

21 CHAIR KIRCHNER: By the inspection  
22 program? Okay. That goes back to Ron and my  
23 earlier --

24 MR. WONG: Yes, the --

25 CHAIR KIRCHNER: -- comments.

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1 MR. WONG: -- vibration review primary  
2 focus on the rapid degradation mechanisms such as the  
3 vortex shedding and fluidelastic instability. Some of  
4 the slow degradation mechanisms can be managed by the  
5 steam generator inspection program.

6 CHAIR KIRCHNER: Well, I wouldn't see  
7 problems on the primary side; the flows are so low  
8 anyway, but certainly I would see problems with the  
9 tubes themselves. And the -- you were contrasting the  
10 -- for the wear issue the fact that the clips that  
11 hold the steam generator tubes in place, those are  
12 much thicker, stiffer I would guess is kind of -- then  
13 the actual tube itself. They're much -- so they're  
14 bent? Those clips are bent out of that --

15 MR. WONG: The support plate.

16 CHAIR KIRCHNER: -- support piece? So  
17 that's not a loose parts issue then?

18 MR. WONG: We're not concerned with loose  
19 part issues just because it's -- the clips are punch  
20 out from the --

21 CHAIR KIRCHNER: It's a punch-out?

22 MR. WONG: -- support columns. They are  
23 one continuous piece.

24 || CHAIR KIRCHNER: Yes.

25 MR. WONG: And as the figure indicates the

1           supports are much stronger than the tubes.

2           CHAIR KIRCHNER: Right. Okay. What about  
3       with the inlet flow restrictors? Have you looked at  
4       failure of those so that -- you potentially don't  
5       loose parts going up this steam generator tubes and  
6       then exiting into the valves.

7           MR. WONG: We look at the vibration for  
8       these inlet flow restrictor, the vibration aperture of  
9       the flow restrictors versus the clearance between the  
10      flow restrictor and the tubes and we have not  
11      specifically addressed the likelihood of those parts  
12      in --

13           CHAIR KIRCHNER: Right, my concern would  
14      be you've got this long rod protruding into the tube  
15      sheets. It's vibrating. And then if you fracture off  
16      a small piece of that, it possibly could go right up  
17      the steam generator and out. And there are valves,  
18      important valves on the exit side of the steam  
19      generator.

20           MR. MAKAR: I think there are a couple of  
21      ways to deal with that, and they don't involve what to  
22      do at the valve, but that would have to be addressed  
23      if it were damaged or the parts were in there, I  
24      think. But I think the -- if for example, during an  
25      inspection you find that a piece is missing from the

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1       flow restrictor, then aside from the damage to the  
2       flow restrictor, then you're going to be looking for  
3       damage to the tubing --

4                     CHAIR KIRCHNER: Right.

5                     MR. MAKAR: -- for your inspection process  
6       and/or that there's a part captured in the --

7                     CHAIR KIRCHNER: That's my concern.

8                     MR. MAKAR: -- tube.

9                     CHAIR KIRCHNER: Downstream you have -- of  
10      the tubes you have some important valves --

11                    (Simultaneous speaking.)

12                    MR. MAKAR: Right, I think if there was  
13      something missing and you didn't find it, then you  
14      would have to go and inspect those things downstream.

15                    MEMBER MARCH-LEUBA: In their defense, the  
16      first half of the tube is a steam flow --

17                    CHAIR KIRCHNER: Yes.

18                    MEMBER MARCH-LEUBA: -- and it's going  
19      uphill. It would be hard to carry anything that's not  
20      a snowflake. I mean it's steam and it's a gas.

21                    CHAIR KIRCHNER: Yes.

22                    MEMBER MARCH-LEUBA: It's not a  
23      significant flow of water going uphill.

24                    CHAIR KIRCHNER: Yes, but it's at a good  
25      velocity.

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1 MEMBER MARCH-LEUBA: Yes.

2 CHAIR KIRCHNER: So, but you have done an  
3 analysis of the actual potential fatigue of those  
4 inserts that are part of the flow restrictor?

5 MR. WONG: The inlet flow restrictors are  
6 tested. There are no analysis performed for flow-  
7 induced vibration.

8 CHAIR KIRCHNER: Well, I'm just concerned  
9 that the fatigue life of those individual restrictors  
10 may lead to mechanical failure and then a loose part  
11 issue.

12 MR. WONG: We can confirm with NuScale if  
13 the ASME Section 3 stress analysis -- will also --

14 CHAIR KIRCHNER: So that if the code  
15 would --

16 MR. WONG: -- provide a fatigue analysis.

17 CHAIR KIRCHNER: -- require them to  
18 analyze that as well?

19 MR. WONG: Yes, ASME Code requires fatigue  
20 analysis.

21 CHAIR KIRCHNER: We talked about the plate  
22 itself vibrating, but the individual flow restrictors  
23 as well would be analyzed for fatigue?

24 MR. WONG: The ASME Section Code analysis  
25 will --

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1 CHAIR KIRCHNER: Okay.

2 MR. WONG: -- require fatigue analysis,  
3 and we need to have NuScale to confirm the flow  
4 restrictor will also perform ASME Section 3 analysis  
5 as well.

6 CHAIR KIRCHNER: Okay. Thank you.

7 Bruce?

8 MR. MAKAR: I have just a couple of slides  
9 to address, some of the other topics that have come up  
10 in these discussions. One is the accident analysis.  
11 We recognize that steam generator design affects  
12 accident analyses of the -- it affects the temperature  
13 and pressure at the initiation of an event. The  
14 geometry of the steam generator would affect the flow  
15 and the other conditions, the supports and the steam  
16 generator itself. And that the -- but overall the  
17 steam generator design features don't have large  
18 effects on accident analyses and the biggest effect is  
19 on the tube break event. And the flow restrictor  
20 design and the density wave oscillation does not have  
21 a large effect on the accident analysis either.

22 MEMBER MARCH-LEUBA: Since you brought it  
23 up; I was going to bring it during the closed session,  
24 but one thing I'm concerned about, and it will become  
25 apparent why I'm concerned about two weeks from now or

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1 -- no, next month, is that if you have density wave  
2 oscillations, you have large flow oscillations,  
3 meaning that you are doubling or tripling the liquid  
4 velocity and covering parts of the core that past the  
5 tubes that are not -- that are blanketed with the  
6 steam and now they're blanketed with water.

7                   So in the analysis that NuScale performed  
8 they were concerned about reducing the effectiveness  
9 of the heat -- the steam generator, the heat transfer  
10 coefficient of the steam generator because the steam  
11 boundary would also go down actually.

12                  I'm concerned that it will increase it  
13 significantly, because now instead of having a  
14 velocity of one, you'll be oscillating at a velocity  
15 of plus three minus three. Plus three minus three.  
16 And a change of 300 percent in liquid velocity, when  
17 you put it in liquid vol terms, which is the heat  
18 transfer coefficient, it's a significant change in  
19 heat transfer.

20                  So my suspicion is that any accident in  
21 Chapter 15 that involves overcooling will be even more  
22 overcooled if there is instability on the secondary  
23 side. And I would want to make sure that somebody  
24 addresses that. Typically we think that if your heat  
25 exchanger is better, it's better, right? Most of the

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1 time it is. But any event that involves overcooling  
2 I have the gut feeling; again, not an approved  
3 methodology for analysis -- a gut feeling that the  
4 heat transfer coefficient will increase during  
5 instability significantly; just putting on the record,  
6 you don't need to answer, which will contradict your  
7 it does not affect the Chapter 15.

8 MR. MAKAR: Understand. This density wave  
9 oscillation was also -- or secondary side flow  
10 instability was also assumed in the stability topical  
11 report and there was not -- it did not affect the  
12 primary flow, the primary side's stability. And  
13 there's the -- but it wasn't looked at directly. The  
14 stability topical report didn't evaluate the secondary  
15 side density wave oscillation directly.

16 And so next slide, please. So we've  
17 recognized that density wave oscillation occurs and  
18 that it may affect component integrity, that it's  
19 sensitive to the design of the flow restrictors.

20 As we said -- I said earlier that our  
21 inspection program for the steam generators is  
22 designed to address progressive forms of degradation,  
23 and we tried to design rapid forms of degradation out  
24 at the beginning. And so we come back to this idea  
25 that the density wave oscillation is a -- could

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1 generate a type of cyclic load which would have to be  
2 addressed in the ASME Section 3 code calculations and  
3 that we would have access to that through the ITAAC.  
4 And that the applicant is developing that methodology  
5 to analyze DWO, and we'll have to assess that  
6 methodology for that purpose.

7 MEMBER RICCARDELLA: I'm assuming we're  
8 going to hear more on that last bullet in the closed  
9 session?

10 MR. MAKAR: If you want to hear, then we  
11 can do that, yes.

12 MEMBER RICCARDELLA: I think we would.

13 CHAIR KIRCHNER: Okay. We are a little  
14 bit over the schedule. I'd like to stop here and now  
15 turn for the opportunity for public comment.

16 And if there is -- while we are opening up  
17 the bridge line, if there is anyone in the room who  
18 wishes to make a comment, please come forward to the  
19 microphone, state your name and make your comment.

20 Seeing no one, we'll wait for the bridge  
21 line to be opened to the public. If there is anyone  
22 on the public bridge line who wishes to make a  
23 comment, please state your name and make your comment.

24 MS. FIELDS: This is Sarah Fields. I have  
25 one comment, and that is throughout the discussion

1           there's a certain assumption that NuScale would be  
2           involved at the construction/testing phase. I mean,  
3           when there is an actual construction and then initial  
4           testing that NuScale would be somehow involved in  
5           that. And yet my understanding is that another  
6           entity, a utility in this case, the Utah Associated  
7           Municipal Power Systems, intends to submit a COL  
8           application.

9                         And I don't know if there any legal  
10          requirement that in their use of the NuScale design  
11          that means they would in fact be involved at that  
12          site. I know they're planning to, but I don't know if  
13          -- for any COL applicant referring to this design if  
14          they are required to involve NuScale during the  
15          testing and operational phases.

16                         CHAIR KIRCHNER: Thank you, Sarah.

17                         MS. FIELDS: Thank you.

18                         CHAIR KIRCHNER: We will note that  
19          comment.

20                         Is there anyone else on the public line  
21          who wishes to make a comment? Hearing none, we'll  
22          close the bridge line.

23                         MR. SNODDERLY: I'm sorry. Before we  
24          close the bridge line, for those interested members of  
25          the public, we have a change in the agenda. We are

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1 going to go into closed session and we will not open  
2 back up in open session until about 1:45 this  
3 afternoon. NuScale's presentation on turbine missile  
4 analysis will be a completely closed session. The  
5 public will have an opportunity to hear the staff's  
6 evaluation of turbine missiles starting at about 1:45.

If we're much later than that, I'll send an email to those members of the public that have shown an interest thus far. And if you would like me to notify you when we start, please send an email to michael.snodderly@nrc.gov and I'll let you know if it's going to be later than that. But we'll be in closed session until at least 1:45.

14 Please close the phone line now.

15 CHAIR KIRCHNER: Okay. Thank you, Mike.

16 So we're going to take a break here and  
17 recess for about 10 minutes. Let me see, I think we  
18 use that clock. Let's reconvene at 20 after 11:00 and  
19 we'll continue in a closed session.

(Whereupon, the above-entitled matter went off the record at 11:06 a.m. and resumed at 1:50 p.m.)

22 CO-CHAIR KIRCHNER: Okay, we're in open  
23 session. We're going to hear from the staff on  
24 turbine missiles.

25 Let me try that again. We are now in open

1 session, and we are going to hear from the staff on  
2 their evaluation of turbine missiles.

3 MR. BAVOL: Okay.

4 CO-CHAIR KIRCHNER: Please proceed, Bruce.

5 MR. BAVOL: My name's Bruce Bavol, with  
6 staff at Office of NRR. To my right is Sujit  
7 Samaddar, and I believe we have John Honcharik on the  
8 phone bridge line. John, could you?

9 MR. HONCHARIK: Yes, it's John Honcharik,  
10 I'm on the line.

11 MR. BAVOL: Very good, thank you. And  
12 with that, I'll just, I'll turn it over to Sujit.

13 MEMBER BLEY: Let me, before you even get  
14 started, did you get a chance to review their analysis  
15 or do any audits on it?

16 MR. SAMADDAR: We actually looked at the  
17 calculations in the ERR, sorry, electronic reading  
18 room.

19 Okay, so I'm Sujit Samaddar, as I've been  
20 introduced. Okay. So in this part of the  
21 presentation, I will address the NuScale selection of  
22 turbine missile parameters used in the barrier design  
23 assessment and the staff's conclusion. That's the  
24 first part. And then I'll move on to the barrier  
25 design itself. Next slide, please.

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The missile parameters must first be determined to evaluate the adequacy of the barriers. NuScale proposes to use half the last stage rotor with blades attached as the bounded missile. This is consistent with EPRI votes and experience referred in NUREG 1275, Volume 11. The bounding missile is a 24-inch radius half-circle of the rotor weighing 3568 pounds.

The staff finds the Applicant's proposed bounding missile acceptable since it is based on a typically sized 50-megawatt turbine with 24-inch radius and 12-inch wide last stage rotor made of typical turbine rotor material. Speed of the missile was determined to be 476 miles per hour based on a 190% destructive oversuit, which is consistent with EPRI reports and NUREG 1275, Vol. 11. And this may answer the question you have raised.

Also to provide reasonable assurance, the staff confirmed that at this speed, the centrifugal stresses exceed the tensile strength of the material, causing ductile failure.

To ensure bounding analysis for a selected turbine design, a COL item, 3.5-1, has been added to the COL Applicant to confirm that the selected turbine design is bounded by the parameters used in the

NuScale FSAR analysis for size, weight, and speed of the postulated low trajectory turbine missile for the last stage of the turbine rotor.

Therefore, based on the above the staff concludes that the bounding missile is acceptable and provides a reasonable assurance when used to evaluate the barriers which protects safety-related SSCs. Next slide, please.

9                   So this is a little bit of the regulatory  
10                  basis and the user barriers. Let us look over it.  
11                  GDC-4 requires SSCs important to safety to be  
12                  appropriately protected against dynamic effects,  
13                  including the effect of missiles that may result from  
14                  equipment failure, such as the turbine.

In the NuScale design, these safety-related SSCs are in the reactor building and the control room building, which are in the low trajectory turbine missile hazard zone. Traditionally, safety-related SSCs have been protected from turbine missiles by reducing the probability of a turbine missile strike on these SSCs to  $10^{-7}$  by a combination of turbine missile integrity, oversuit protection, and favorable orientation.

However, safety-related SSCs can also be protected using barriers, as provided in Regulatory

1       Guide 1.115 and DSRS 351.3. NuScale chose to use  
2       barriers instead as providing the required protection.

3                   So now I'll go into talking about the  
4       evaluation of the barrier itself. Next slide, please.  
5       So this part of the presentation will address  
6       NuScale's selection of turbine missile barriers and  
7       the acceptance criteria, the methodology assessment,  
8       analysis results, and staff's conclusions. Next  
9       slide, please.

10                  A barrier is deemed as effective only if  
11       missile impact there are no objects dislodged from the  
12       back face of the barrier, creating secondary missiles,  
13       or that the barrier is not perforated, allowing the  
14       missile to eject from the other face. Next slide,  
15       please. Sorry, I skipped a slide, let's go back one.

16                  NuScale considered the following as  
17       barriers providing protection to the safety-related  
18       SSCs. So it's five-foot thick reinforced concrete for  
19       the reactor building, and three-foot walls and flow  
20       slabs for the control room building. So next slide,  
21       please. Okay.

22                  The user barriers for protection against  
23       turbine missiles is a first-of-kind approach. And  
24       there is no standard review process. Therefore, the  
25       staff considered for the review of this application

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the analytical approach, the reliability in simulating the impact mechanism, and the rationality of the results.

4                   A barrier is accepted for missile  
5 protection by the staff if the barrier is not  
6 perforated, not generate secondary missiles from  
7 scabbing off back face. Imperial relationships, such  
8 as the modified NDRC formula, establishes the minimum  
9 thickness of a barrier which would meet the acceptance  
10 criteria based on how deep a missile would penetrate  
11 on impact.

12 NuScale's approach was to determine the  
13 depth of penetration using a finite element code that  
14 was suitable for a high energy, small contact impact  
15 on concrete walls and the use of the NDRC relations to  
16 establish the minimum thickness required for adequate  
17 protection. Next slide, please.

18 NuScale used a well-established, non-  
19 linear finite element-based computer program Teragram  
20 to provide a reasonable assurance that the code was  
21 appropriate for impact of high analysis, high energy,  
22 low contact area missiles. The code was used to  
23 simulate actual turbine missile tests performed by  
24 EPRI.

## Comparison of the simulated and test

1 results showed a close prediction capabilities of the  
2 software with respect to missile penetration depth and  
3 exit velocities in the case of missile perforation.  
4 Next slide, please.

5 NuScale's analysis considered missile  
6 impact at the center of the modeled wall, which was  
7 smaller than the dimensions of the actual wall. The  
8 selection of the location was based on the location  
9 that would render the maximum damage to the wall.  
10 Near edge and corner strikes low transfers to the  
11 heavy support elements, reducing the damage to the  
12 wall. Next slide.

13 The plotted strength contours on the  
14 analysis show that the strain drops rapidly to zero  
15 with distance from the impact location. Thus, the  
16 closeness of the boundaries of the modeled wall do not  
17 impact the strength profile of the impacted site. A  
18 very localized impact effect was shown, with the  
19 missile energy being dissipated by the penetration or  
20 the perforation of the missile.

21 This reduction in missile energy was  
22 evidenced by the much reduced missile exist velocity  
23 from the control room building wall. For the reactor  
24 building, the depth of penetration was near the full  
25 thickness of the wall. All SSCs behind the wall was

1                   considered as lost from secondary missile impact.

2                   For the control room building, the wall  
3                   was fully perforated, and the penetration of the slab  
4                   was small, and the slab meets the acceptance criteria  
5                   discussed before. NuScale therefore did not consider  
6                   any global effects from the missile impact in the  
7                   building member design. Last slide.

8                   Based on the simulated results and the  
9                   ability of Teragram to replicate the results from the  
10                  actual turbine missile impact, the staff concluded  
11                  that there is reasonable assurance that the simulated  
12                  results reflect the turbine missile impact, and that  
13                  barriers considered will protect the safety-related  
14                  SSCs in the NuScale design, as required by GDC-4.

15                  And that concludes my, the staff  
16                  evaluations.

17                  MEMBER BLEY: Thank you but would you show  
18                  your first backup slide and tell us what that's about.

19                  MR. SAMADDAR: Okay, so this slide was  
20                  meant to demonstrate one thing and one thing only.  
21                  That shows an ordinance going through three walls --

22                  MEMBER BLEY: It's a military test.

23                  MR. SAMADDAR: Yes. And the idea is there  
24                  is no global impacts. The whole wall does not come  
25                  crumbling down, it's only just localized portions are

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1 getting blown away.

2 MEMBER BALLINGER: For reference purposes  
3 in GPU57, is that's what is right here, will go  
4 through 200 feet of concrete before exploding. We  
5 don't have to worry about that.

6 MR. SAMADDAR: This is before that.

7 MEMBER BLEY: What we'd seen this in  
8 earlier work is if the missile gets through easily the  
9 first barrier but can't get out of the second, it does  
10 weird stuff inside. It's like a pinball machine.

11 MR. SAMADDAR: So I'm open for questions  
12 if there are any.

13 CO-CHAIR KIRCHNER: This is a great  
14 picture. I'm familiar with this stuff. I think we  
15 can see the projectile coming out. It's unlikely  
16 you'll get a projectile like that designed for,  
17 specifically for penetration, from a turbine rotor  
18 disintegrating. Just a, so apples and oranges. This  
19 is specifically designed to go through concrete. It's  
20 a good picture.

21 Members, any other questions or the staff?

22 MEMBER RICCARDELLA: Did the staff have  
23 the complete analysis document, or did they just  
24 review what was in the DCA?

25 MR. SAMADDAR: No, we looked at the CAT

1 computations and the pictures of the plots in the  
2 electronic reading room, so we did look at it.

3 MEMBER RICCARDELLA: Oh, you did, okay.

4 MR. SAMADDAR: And the code is a well-  
5 established code because it's extensively used in AIA  
6 work and it's familiar with ACRS too because we have  
7 presented it before.

8 CO-CHAIR KIRCHNER: Dennis, is that?

9 MEMBER BLEY: Nothing more from me.

10 CO-CHAIR KIRCHNER: I neglected to  
11 announce that you were chairing, or co-chairing this  
12 part of the meeting.

13 MEMBER BLEY: I'm pleased, thank you for  
14 sharing that.

15 CO-CHAIR KIRCHNER: Well, that's a hint  
16 that Dennis is also going to draft a letter on this  
17 topic. Right? Yes, thank you.

18 Okay, if there are no further questions,  
19 then I thank the staff and the Applicant for your  
20 presentations.

21 MR. SAMADDAR: Thank you.

22 CO-CHAIR KIRCHNER: Just a minor  
23 housekeeping. We're going next to open session on the  
24 inadvertent actuation block valve. And as several  
25 more open sessions are, I remind everyone that you

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1 have proprietary material. If you do not wish to keep  
2 it, please return it to Mike so we can take proper  
3 care of it.

4 Thank you, Bruce. Okay.

5 (Off-record comments.)

6 CO-CHAIR KIRCHNER: We're back in session.  
7 We are going to hear from NuScale on the emergency  
8 core cooling system valves, and in particular the  
9 inadvertent actuation block design. And I'm going to  
10 turn to Paul Infanger from NuScale to start.

11 MR. INFANGER: Good afternoon. Paul  
12 Infanger from NuScale Licensing, and we're going to  
13 present some information about the emergency core  
14 cooling system valves and the inadvertent actuation  
15 block designs.

16 So with me here is Dan Lassinger from  
17 NuScale Engineering, and he's going to start off the  
18 presentation.

19 MR. LASSINGER: All right, thanks, Paul.  
20 So we've had a couple of presentations about the ECCS  
21 valve design and operation previously. This  
22 presentation is really to summarize the DCA  
23 demonstration test program, which was designed and  
24 carried out in 2019.

25 MEMBER BLEY: That is complete.

1                           MR. LASSINGER: It's complete, right. And  
2 specifically we'll focus on the performance of the  
3 inadvertent actuation block feature of the ECCS valve  
4 design, and we won't talk too much about the rest of  
5 the valves at this point.

6                           Just to quickly recap the function of the  
7 ECCS valves and the role of the inadvertent actuation  
8 block feature, I'll refer to it as the IAB from here  
9 on out. The ECCS valves receive a demand to open on  
10 a actuation signal from the module protection system  
11 or on a loss of DC power, a loss of power to the ECCS  
12 trip solenoid valves, pilot-actuated valves, so those  
13 would create a demand for the ECCS main valves to  
14 open.

15                          However, if the pressure in the reactor  
16 vessel is sufficiently high, then the IAB will  
17 interfere or engage to prevent the opening of the ECCS  
18 valves. Effectively, this prevents the opening of the  
19 ECCS valves due to spurious signals or equipment  
20 failure at normal operating pressures, but permits  
21 opening of the ECCS valves at LOCA conditions at lower  
22 pressure.

23                          In the initial DCA submittal, the IAB  
24 pressure range was 1000-1200 psi. And what I mean by  
25 that is that over 1200 psi, the IAB would interfere to

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1 block the main valves from opening if there was a  
2 spurious signal or equipment failure.

3 (Off-mic comments.)

4 MR. LASSINGER: What's that?

5 MEMBER BLEY: I said or a --

6 MR. LASSINGER: There are no demands of  
7 the ECCS in which the IAB would be, would interfere.

8 CO-CHAIR KIRCHNER: But no, no, the  
9 signal. You have two signals from your module  
10 protection system. You've got containment level and  
11 low pressure, low, low pressurizer level --

12 MR. LASSINGER: But a signal from module  
13 protection system would only be on a high containment  
14 level, which in that condition, the reactor pressure  
15 would be lower. It would be below the 1000 psi. So  
16 the IAB would never be interfering in our LOCA  
17 situations in which we have a, I'll say a valid demand  
18 for ECCS by the module protection system.

19 CO-CHAIR KIRCHNER: Do you know that for  
20 sure?

21 MR. LASSINGER: We know that for sure.  
22 I'd have to defer this a little to the scope of the  
23 safety analysis considered because it's dependent on  
24 many --

25 CO-CHAIR KIRCHNER: I'm thinking of the

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1 containment level signal. If you got a spurious  
2 signal there or you actually had water accumulating in  
3 the containment.

4 MR. LASSINGER: I think the best thing for  
5 me to say at this presentation is that that's  
6 supported by the scope of safety analysis performed in  
7 Chapter 15.

8 CO-CHAIR KIRCHNER: Okay.

9 MR. LASSINGER: So over 1200 psi, the IAB  
10 was specified in the valve performance specs to block  
11 to prevent the ECCS main valves from opening. And  
12 this supports meeting CHF criteria for postulated  
13 spurious openings of the ECCS valves where there was  
14 a rapid depressurization. The lower level, 1000 psi,  
15 you know, to permit the ECCS valves to open, was based  
16 on protecting coolant levels for small breaks.

17 In other words, some small break that  
18 occurs for a long time where reactor level is getting  
19 lower but reactor pressure is not reducing  
20 significantly. So that was the basis for that range.  
21 Next slide.

22 A little more background, and we did do  
23 some proof of concept testing of the ECCS valves in  
24 2015, we've talked about this before. But this was  
25 done with air and room temperature water. This was

1 primarily to support design development of the ECCS  
2 valves, specifically unique aspects like the IAB  
3 function of the concept and the fact that the  
4 actuation, the pilot actuators are remotely positioned  
5 from the main valve. Next slide.

6 During the DCA review, it was determined  
7 that additional demonstration of the ECCS valve  
8 functionality was required to satisfy 10 CFR 5034. So  
9 a test program was designed and executed up to  
10 operating and temperatures and pressures. So with hot  
11 water and steam at the reactor operating temperatures  
12 and pressures.

13 And tests were carried out in pressures to  
14 actuate ECCS below the IAB range, so below 1000 psi,  
15 and above the IAB range, which would be representing  
16 a spurious signal or a failure to see if the IAB  
17 blocked and blocked in time. Which it did for some  
18 pressures above.

19 However, in the execution of the test  
20 program, we did observe that the kind of two-phase  
21 effects slowed the IAB response and prevented the IAB  
22 from reliably blocking and releasing within that 200  
23 psi window. It did block and release as expected, but  
24 the range was greater than was previously specified.

25 So it was initially a range of 200 psi.

We did a series of sensitivity tests at that point and made a few adjustments to the IAB valve performance, which had to do with a spring force in internal orifices of the valve assembly, and determined that a minimum range to satisfy functionality of the valve was 400 psi.

7 So we need a 400 psi window to reliably  
8 block and then reliably release with operating margin  
9 to, you know, that was, in the current state of the  
10 valve design, that was the limitation that we needed  
11 to work with. So --

12 MEMBER BLEY: How many test trials were  
13 done to come to this conclusion? You know, I'm not  
14 surprised that the range is bigger than you'd hoped.  
15 But it might even be bigger than you think, unless you  
16 did a fair number of tests.

17 MR. LASSINGER: Maybe somebody on the  
18 phone can help identify the exact number, but it was  
19 on the order of 20 to 40 test runs at --

20 MEMBER MARCH-LEUBA: How many valve, how  
21 many pieces of equipment, only one?

22 MR. LASSINGER: This is only one piece of  
23 equipment.

24 MEMBER MARCH-LEUBA: One piece of  
25 equipment around 40 times.

1                   MR. LASSINGER: One 40 times. We'll point  
2 out Paul has a slide to this later that we still have  
3 qualification, functional qualification to be  
4 performed on these valves. So this is not the end of  
5 the testing before the valves go into service, this is  
6 just the testing to support functionality for DCA. So  
7 there's still an entire qualification test program  
8 that's required prior to any valve going into service.

9                   MEMBER BLEY: I haven't seen the details  
10 of your qualification testing, but I've seen some  
11 others. And often you qualify if you get it to work  
12 once. You can fail a few times, and then if you  
13 finally get it to work, it's qualified. Are we like  
14 that, or do you have any idea?

15                  MR. LASSINGER: I don't have a great sense  
16 I think off, you know, off the cuff of what the number  
17 of -- I know there are margins which are required to  
18 be applied to the qualification program. So we have  
19 margin between what you expect to happen and what the  
20 limit is. So what the valve spec limit is. So that  
21 is supposed to account for operational uncertainty and  
22 fabrication uncertainty of the valve itself.

23                  MEMBER BLEY: Let me ask it another way.  
24 In the test that you did do, did you find open and  
25 closing was over exactly a 400 psi range, or was it

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1 less than that --

2 MR. LASSINGER: It was less than --

3 MEMBER BLEY: And you went to 400 to give  
4 you some margin.

5 MR. LASSINGER: That's correct.

6 MEMBER BLEY: Margin.

7 MR. LASSINGER: That's correct, yeah.

8 There was around --

9 MEMBER BLEY: Do you know the minimum and  
10 max? How close are we?

11 MR. LASSINGER: It's difficult to, well,  
12 it's difficult to determine the exact minimum but we  
13 did have closing pressures at around 1275. So that's  
14 a 25 psi -- or sorry, let me, I didn't get to the last  
15 bullet of this slide.

16 So the new range is 900 psi to 1300 psi.

17 So we established multiple tests to show the,  
18 demonstrate the blocking at a pressure below 1300. It  
19 blocked it around 12, you know, a little bit of  
20 variation, 1270-1275, multiple test. And the release  
21 was near 950, 925 to 950. So there's a 25 to 40 psi  
22 range.

23 MEMBER BLEY: Okay, so pretty close.

24 MR. LASSINGER: Yeah.

25 MEMBER BLEY: So you tuned it pretty close

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1 to what you saw in a 1000.

2 MR. LASSINGER: That's true, but yeah,  
3 there was also --

4 MEMBER BLEY: I asked a question four  
5 times ago when we talked about these, and I don't  
6 remember I got an answer that made me comfortable.  
7 Something led you to really worry about spurious  
8 operation of ECCS valves to go to this kind of  
9 elaborate function. And they don't spuriously operate  
10 very often in my experience. What is it that pushed  
11 you to do this?

12 Because this, you know, you don't want to  
13 have an unreliable system, and that's what you're  
14 protecting against. But I'm surprised that it drove  
15 you to this, which challenges the safety role of these  
16 valves.

17 MEMBER MARCH-LEUBA: It has to do with our  
18 next topic. The power to the valve is unreliable  
19 because it's not safety-related.

20 MEMBER BLEY: What do we mean by  
21 unreliable?

22 MEMBER MARCH-LEUBA: Not safety-related.

23 MEMBER BLEY: Well, it's highly reliable.

24 MEMBER MARCH-LEUBA: But these guys behind  
25 you will force you to assume it fails twice a week

1 because it's not safety-related. You have to be to  
2 survive that.

3 MR. INFANGER: You wouldn't want ECCS  
4 inadvertently actuating at that full pressure.

5 MEMBER BLEY: No, you wouldn't, but you  
6 sure don't want it not to work when you want it to  
7 work.

8 MR. INFANGER: Yeah, the timing is not  
9 real critical on the ECCS function. That's why the  
10 delay is not a problem in the analysis.

11 MEMBER BLEY: Delay as long as it works,  
12 yeah.

13 MR. INFANGER: Yeah. And it's, the  
14 release is before you hit the 900 pounds.

15 MEMBER BLEY: You really have no reason to  
16 expect that you would have inadvertent operation very  
17 often, if ever.

18 MR. INFANGER: Yeah, we don't expect it,  
19 but it is required to be postulated by the Chapter 15  
20 analyses. And the limit is the critical heat flux  
21 depressurization criteria that we have to meet. So  
22 that's --

23 MEMBER BLEY: So you're it's a Chapter 15  
24 issue you're protecting against?

25 MR. INFANGER: Yes.

1 MEMBER BLEY: Although there's no  
2 probability associated with Chapter 15 events.

3 MR. INFANGER: That's right.

4 MEMBER BLEY: I still don't get it. Go  
5 ahead.

6 MEMBER MARCH-LEUBA: If you have safety-  
7 related power you have to, that means you can live  
8 without it. It can fail every Monday.

9 MR. INFANGER: Deterministically we  
10 assumed DC power fails. So then you would --

11 MEMBER MARCH-LEUBA: Yeah, if it's not  
12 safety grade, you have to demonstrate that you need  
13 it.

14 (Simultaneous speaking.)

15 MEMBER MARCH-LEUBA: Or the ECCS valve  
16 would open every Monday.

17 MEMBER BALLINGER: Does the operator have  
18 to demonstrate operability before startup each time?

19 MR. INFANGER: Yes, it's a in the --

20 (Simultaneous speaking.)

21 MEMBER SUNSERI: Dan, I don't know if this  
22 makes any difference or not, but in your testing  
23 sequence for this determination, this three to four  
24 hundred range, did you do anything to account for the  
25 fact that you're essentially preconditioning valve?

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1 Like stroking it so many times, and in actuality this  
2 valve is probably going to be sitting for long periods  
3 of time before it has to do its function?

4 MR. LASSINGER: Well, it is sitting for  
5 long periods of time, but it's sitting at operating  
6 pressure and temperature. And the temperature really  
7 actually was a contributing factor, for example, to  
8 the IAB spring force. Maybe as expected, the  
9 temperature is a --

10 MEMBER SUNSERI: But all I'm saying is,  
11 you know, if you were going to test it 20 times and  
12 you did it today, versus the fact that it might only  
13 operate once every 18 months, that's a different  
14 story. We've seen on containment isolation valves,  
15 you test them and they work fine. Then you go to test  
16 them again, they don't.

17 MR. LASSINGER: I don't have any, it's a  
18 good question, I don't have any specific mechanism  
19 that I have a concern about that would be, that would  
20 change its, the IAB characteristic in the plant if it  
21 was sitting for a period of time. And actually as  
22 this member just identified, we do have tech specs to  
23 address the functionality of the ECCS valves and  
24 specifically the IAB function.

25 I believe there's a slide on that towards

1           the end about the in-service testing aspects that were  
2           actually updated as a result of this test program  
3           also. So maybe that will help.

4           MEMBER MARCH-LEUBA: I'm confused, can we  
5           backtrack on what we're talking about? You're talking  
6           about block and release. Block means if my pressure  
7           is above 1300, it will never open. Or does it have  
8           the specific -- tell me what this block, what this  
9           means.

10           MR. LASSINGER: The IAB is, you know, this  
11           differential pressure valve with the spring inside  
12           the, you know, I'll say attached to the main ECCS  
13           valve. If there's a significant enough differential  
14           pressure, so the reactor vessel pressure is too high  
15           compared to containment, the IAB rapidly moves to  
16           close, yeah.

17           We do have some reference figures  
18           available that we looked at previously.

19           MEMBER MARCH-LEUBA: No, no, just tell me  
20           --

21           MR. LASSINGER: So it, so the --

22           MEMBER MARCH-LEUBA: What's the difference  
23           between the block --

24           MR. LASSINGER: Yeah, the IAB will move --

25           MEMBER MARCH-LEUBA: Tell me the

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1 difference between release and not block.

2                   MR. LASSINGER: Release is if there was an  
3 initial block. So say we're at operating conditions.  
4 A solenoid valve fails. The trip solenoid valves  
5 open, the main valve control chamber tries to start  
6 venting, but the differential pressure is so high that  
7 the IAB closes and prevents the depressurization of  
8 this relief valve of the ECCS valve --

9                   MEMBER MARCH-LEUBA: So release, the IAB  
10 valve is closed, and it has to open.

11                  MR. LASSINGER: It's normally open. It  
12 will go to the closed position to stop the main valve  
13 from opening. So it'll --

14                  MEMBER MARCH-LEUBA: So that's blocking.

15                  MR. LASSINGER: That's blocking.

16                  MEMBER MARCH-LEUBA: That's blocking.

17                  MR. LASSINGER: And the main valve will  
18 stay closed.

19                  MEMBER MARCH-LEUBA: So what is release?

20                  MR. LASSINGER: Release is if there is an  
21 actual LOCA occurring, pressure will decrease in the  
22 reactor vessel to, you know, this 900 psi. And then  
23 the IAB will open and allow the ECCS valves to open.  
24 And the difference between a release and a not block  
25 is that if you were at, if you were over 900 psi

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1 before the scenario started, basically, if you're  
2 below 900, the IAB will just never interfere and the  
3 ECCS valves will open.

4 MEMBER MARCH-LEUBA: I understand below  
5 900 and above 1300. I don't understand what happens  
6 between 900 and 1300. I still don't understand.

7 MEMBER BLEY: I think what you need to do  
8 is walk him through if the pressure comes down, when  
9 will you get an ECCS actuation.

10 MR. LASSINGER: It's specified now at 950  
11 psi, plus or minus 50 psi.

12 MEMBER MARCH-LEUBA: But if at 12 --

13 MR. LASSINGER: You'll, there's a slide on  
14 that Paul will get to on this, but we determined that  
15 the --

16 MEMBER MARCH-LEUBA: I give up. I give  
17 up, I don't get it. I don't -- I mean, if at 1299 you  
18 failed to block, why doesn't the ECCS open?

19 MR. LASSINGER: Okay, the safety analysis  
20 --

21 MEMBER MARCH-LEUBA: The pressure is going  
22 down --

23 MR. LASSINGER: The safety analysis does  
24 consider the possibility of the valves opening over a  
25 range. This slide in particular doesn't address the

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1 release of pressure by itself. We determined that a  
2 400 psi range window was required for blocking the  
3 release.

4 MEMBER MARCH-LEUBA: So 400 is the  
5 uncertainty on the set point.

6 PARTICIPANT: Yes.

7 MR. LASSINGER: That's how, that's how it  
8 was previously specified. Now we have established  
9 what we call the threshold pressure, which is 1300  
10 psi. It will always block over 1300 psi. Now we have  
11 a release pressure of 950 psi, plus or minus 50. So  
12 --

13 MEMBER MARCH-LEUBA: Is that an analytical  
14 limit, or does it have anything to do with reality?

15 MR. LASSINGER: It's used in the safety  
16 analysis and that's supported by the test program --

17 MEMBER MARCH-LEUBA: Analytically.

18 MR. LASSINGER: And it's supported by the  
19 test program with margins --

20 MEMBER MARCH-LEUBA: I was basing some  
21 kind of probability that one in a thousand would  
22 always be blocked, and 1300, and one in a thousand  
23 would always be open below 900. But most of them  
24 would open at 1150.

25 MR. LASSINGER: No, the --

1 MEMBER MARCH-LEUBA: I don't get it.

2 MEMBER SUNSERI: I think it sounds  
3 analogous to like a safety valve that has blowdown and  
4 accumulation, right. So you got to get above a set  
5 point before it gets fully open, and you got to get  
6 way before it before it's going to fully close. And  
7 that's kind of how this thing's working.

8 MR. LASSINGER: That's correct, yeah.  
9 There's, the period between 1300 and the 1000 is the,  
10 that additional I'll say Delta P we need to reliably  
11 hold the IAB closed, which to your point that's how it  
12 works.

13 MEMBER MARCH-LEUBA: It is not normally  
14 down, and if only it goes up or down depending, when  
15 you lose power and you try to open ECCS. So there is  
16 -- is it a -- I give up. It's an uncertain.

17 MR. LASSINGER: Well, let's, I think I'll  
18 turn it over to Paul to talk about how this, these  
19 results were incorporated into the safety analysis.  
20 Because this is a change, you know, from the 1200 to  
21 the 900/1300. And this may, I think it may help  
22 answer a few questions with performance of ECCS in the  
23 NuScale plan.

24 MR. INFANGER: Yeah, and before we move  
25 on, I believe Corvallis has some information about the

number of tests that were done for the IAB. If you'd unmute your.

3 MR. WUTH: Yes, this is Braden Wuth  
4 speaking from the NuScale office. We, at each test  
5 condition we performed at least three repeatability  
6 runs to make sure that there wasn't any variation  
7 caused by minor changes in temperature or pressure of  
8 the condition.

9                   And Dan spoke correctly, when we were  
10                  investigating and doing sensitivity studies, we did  
11                  approximately 20-40 individual runs at the facility to  
12                  try and determine the block and release pressures.

13 MEMBER MARCH-LEUBA: So let me see if I  
14 can understand what you said and maybe helps the  
15 previous question. In this test you set up a Delta P  
16 across the ECCS valve of 1400, and then you remove  
17 power, and then see the slope. Then, and you do it  
18 three times to make sure it's different. And you do  
19 the 1350, doesn't open. Then you do it, call it 1299  
20 so it's below 1300, and it opens?

21 MR. LASSINGER: We did a series of tests,  
22 you know, from 1300, 1275, you know, 1260, 1250 --

23 MEMBER MARCH-LEUBA: And what happens at  
24 those intermediate pressure between 1300 and 900? It  
25 sometimes opens and sometimes doesn't open?

1                   MR. LASSINGER: Below, well, it either  
2 blocks or it doesn't block.

3                   MEMBER MARCH-LEUBA: Yeah.

4                   MR. LASSINGER: And right, so we establish  
5 that it will always block around, you know, in that  
6 test configuration, and which is basically identical  
7 to the IAB final valve design. It blocked at around  
8 1250 psi, and so we did test repeatedly at 1275 to  
9 establish that it blocks at 1275, 1275 each time,  
10 which is below the 1300 which we established as the  
11 limit.

12                  So it, so in terms of safety analysis  
13 credit, we can always say that it blocks over a  
14 pressure of 1300 psi. Safety analysis does still take  
15 account for the fact that it may not block between  
16 that range that you're talking about that range that  
17 you're talking about --

18                  MEMBER MARCH-LEUBA: So there's an  
19 uncertainty whether it will block or not --

20                  MR. LASSINGER: That's right --

21                  MEMBER MARCH-LEUBA: Between 1275 and 950.

22                  MR. LASSINGER: And in fact, I think  
23 you're talking about different considered staggered  
24 releases or blocking that were considered because of  
25 that effect.

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1 MEMBER MARCH-LEUBA: For a spring and a  
2 well very defined surface area, that's a very large  
3 uncertainty. I mean, it's a regular spring --

4 MEMBER BLEY: It's not untypical of these  
5 kind of valves. We've, I've never tested one, and  
6 it's been a long time since I tested them, never, ever  
7 tested or had them tested and they came anywhere close  
8 to their set points. So these are better than I'm  
9 used to seeing.

10 MEMBER MARCH-LEUBA: No, no, there is only  
11 one valve that has one set point.

12 MEMBER BLEY: The set point was, I assume,  
13 1200.

14 MEMBER MARCH-LEUBA: No, he's telling me  
15 that sometimes it opened, sometimes it didn't.

16 MEMBER BLEY: Yeah, when it was set to  
17 operate at 1200, if I understood you guys right.

18 MEMBER MARCH-LEUBA: You're going to  
19 change the set point. It's given by the spring and  
20 the surface area. There is no adjustment, it's  
21 whatever the set point is.

22 MEMBER BLEY: I'm sorry, but they all have  
23 adjustment.

24 MR. LASSINGER: The issue is the amount of  
25 Delta P between the reactor and containment to

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1 reliably hold the IAB in the closed position. When  
2 you start getting closer and closer to the release set  
3 point, then the force balance across the disk is  
4 approaching zero.

5 So it does not reliably hold it closed and  
6 it could start to leak as you're approaching, you  
7 know, the spring force, the force balance per spring  
8 force is going to zero across the disk. So we need  
9 that, you know, when I say 400 psi, I mean that's the  
10 limit. But we're a little bit inside of that in terms  
11 of operations.

12 MEMBER MARCH-LEUBA: So the issue is the  
13 valve actually moves, but it leaks. You need more  
14 force to hold it.

15                           MR. LASSINGER: That's why we need a wider  
16 range, and you can't, you know, that's why we need the  
17 range from 900 to 1300 psi, correct.

18 MEMBER MARCH-LEUBA: And you tested it  
19 1000 times to make sure that that's a range, or you  
20 tested it three times. Oh, 45 times under pressure.  
21 They only tested three that it worked.

22 MR. LASSINGER: Well, we tested a number,  
23 it was more than three. There was a number of test  
24 series, maybe more like ten test series to establish  
25 that blocking pressure. Establish that it blocks

1 below 1300 psi. So any pressure above 1300 psi is  
2 more pressure to close the valve. So there's no,  
3 that's better performance --

4 MEMBER MARCH-LEUBA: What I understand,  
5 this is a probabalistic assessment that you did.  
6 Sometimes it moved, but it didn't, but it leaked, and  
7 it wasn't really closing. Sometimes it moved when it  
8 closed and sometimes it didn't, in between 900 and  
9 1300. If you're above it, it always worked.

10 MR. LASSINGER: That's right.

11 MEMBER MARCH-LEUBA: But how many runs did  
12 you run above 1300? More than three?

13 MR. LASSINGER: Well, you know, from my  
14 perspective, running any pressure below 1300 is much  
15 more conservative because that's the less pressure to  
16 hold the IAB closed. Any pressure higher holds the  
17 IAB closed better, I'll say. So there's no --

18 MEMBER MARCH-LEUBA: It's of no safety  
19 concern. I, yeah, no, I -- you guys need to  
20 understand what you're doing. I mean, if you cannot  
21 explain to me what you're doing, I don't think you  
22 understand what you're doing. You cannot explain to  
23 me what this means. I'm sorry, must have half-  
24 caffeine in here. I mean, do you understand what I'm  
25 saying?

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1 || MR. LASSINGER: Yeah.

2 MEMBER MARCH-LEUBA: I mean, we've been  
3 going on for 20 minutes, and nobody at this table  
4 understands what you did.

5 MR. INFANGER: Okay, we'll take a look at  
6 the analysis that we did before we did the testing and  
7 afterwards. So prior to getting the new range for the  
8 IAB, we had assumed that the ECCS valves would open  
9 between 1000 and 1200 PSID. So, and above 1200 PSID  
10 it would always block. And that was the assumption we  
11 had made, and it was supported by the initial proof-  
12 of-concept testing.

13 So, and we assumed that all of the valves  
14 opened at the same time. It was a pretty small range  
15 so we, at the time we didn't look at staggered  
16 opening. So that was the analysis that we had done  
17 and submitted in August of 2019.

18                           MR. CHITTY: Hey, Paul, this is Mark  
19 Chitty. We have the test engineers stand by here that  
20 he can maybe add a couple of things.

21 MR. WUTH: Ah, yes, this is Braden Wuth  
22 speaking again. We performed 24 quality test runs to,  
23 above the IAB set points, showing that it blocked each  
24 and every time. We did it at a variety of pressures,  
25 some well above and some, as Dan said, right at the

1       1275 PSID mark, to show that it closed and blocked the  
2       main valve from opening each time.

9 MEMBER MARCH-LEUBA: How about the lower  
10 limit? The 900?

20 MEMBER MARCH-LEUBA: So the uncertainty is  
21 with the blocking.

22 MR. LASSINGER: That's correct. The  
23 release is very consistent.

24 MEMBER MARCH-LEUBA: Are you doing a ramp,  
25 or are you doing steps? For the release.

1                   MR. LASSINGER: It's a ramp. It was a  
2 specified ramp to correlate --

3                   MEMBER MARCH-LEUBA: Because if the issue  
4 is with leaking because it's not closing properly, the  
5 slope on the ramp will give you a different answer.

6                   MR. LASSINGER: That's right. We did  
7 establish the slope, yeah, the rate of pressure  
8 decrease --

9                   MEMBER MARCH-LEUBA: It's irrelevant, it  
10 doesn't make any --

11                  MR. LASSINGER: Taken from safety analysis  
12 results, so. Thanks, Braden.

13                  CO-CHAIR KIRCHNER: So just to clarify  
14 then. So for the release part of the experimental  
15 runs, these were all ramps, not steps.

16                  MR. LASSINGER: That's right.

17                  CO-CHAIR KIRCHNER: I think that's the  
18 right thing. It's, because that's what the valves are  
19 going to see in the actual blowdown conditions.

20                  MEMBER BLEY: Although it's back to what  
21 Matt said.

22                  CO-CHAIR KIRCHNER: Yeah.

23                  MEMBER BLEY: For the first one, yeah.  
24 After you've operated it one time, unless you let it  
25 sit for months without pressurizing, you're going to

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1 be really consistent. I'm surprised they're not  
2 consistent on the high end too, given consecutive  
3 sets.

4 CO-CHAIR KIRCHNER: Okay. Keep going,  
5 Paul.

6 MR. INFANGER: Okay, so the analyses that  
7 were of interest was the containment peak pressure in  
8 Chapter 6, loss of coolant in Chapter 15, and the  
9 inadvertent opening of an ECCS valve in Chapter 15.

10 So we revised the accident analysis  
11 assumptions to match the, what the testing had  
12 determined. And the, so we assumed that the IAB  
13 blocks above 1300 PSID and opens between 900 and 1000  
14 PSID.

15 And we submitted the revised analysis in  
16 September of 2019, and then the staff came out to  
17 Corvallis with a group of about ten people. And the  
18 primary subjects were to review these calculations and  
19 review the testing and a few other issues. But this  
20 was one of the focus areas.

21 And so then we submitted, so the NRC, you  
22 know, they reviewed the calculations and saw what  
23 changes we were going to make to the FSAR, we had  
24 markups and had submitted them. And then we submitted  
25 the formal DCA revision 4 with the new updated results

1           in January, just a month ago, a few weeks ago.

2                         Okay, so the impact of these changes on  
3                         the IAB to the analysis resulted in increased peak  
4                         containment pressure. The reason the containment  
5                         pressure went up was that the limiting event is an  
6                         inadvertent opening of an RRV. So it's one of the  
7                         recirc valves, so you're releasing fluid to the  
8                         containment.

9                         And the second, in the new analysis, the  
10                         second RRV opens at 1000 PSID, and the RVVs don't open  
11                         for another 100 pounds. So what happens is you get a  
12                         second recirc valve opening up. So you get more fluid  
13                         into containment, the greater amount of mass then  
14                         results in a slightly higher pressure. So that's was  
15                         a difference.

16                         Before, we had assumed that the valves,  
17                         the vent valves opened at the same time as the recirc  
18                         valves. You get a, the containment pressure and the  
19                         RCS equalized pressure very quickly. And therefore  
20                         you, it, then that decreases the amount of mass that  
21                         gets out into containment quickly, so.

22                         CO-CHAIR KIRCHNER: So that one, Paul, I  
23                         reviewed Chapter 6, Jose reviewed Chapter 15. On  
24                         Chapter 6, I think I must have been looking at Rev 3.  
25                         So how much, you had from Rev 2 to Rev 3, to, at least

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on paper, redesign the containment vessel pressure rating. It was originally 1000.

3                   After you analyzed one RBV opening, you  
4                   were close to that and you redesigned to 1050. How  
5                   close now are you with this scenario to the design  
6                   limit of 1050 psi?

7 MR. INFANGER: I have the results on the  
8 next page. But it went up by about eight pounds. So  
9 it went from 986 to 994, if that gets the various  
10 results. But it's less than one percent increase, so  
11 it was relatively small.

12 And that, again, that was just due to the  
13 large amount of water that gets out into the  
14 containment prior to the pressures equalizing.

15 For the --

16 CO-CHAIR KIRCHNER: Did you do a  
17 sensitivity analysis, since you have a range now?

18 MR. INFANGER: Yes.

19 CO-CHAIR KIRCHNER: That's broader than  
20 your initial range of where actually it releases. So  
21 your assumption is it holds until 1000 psi, the second  
22 valve?

23 MR. INFANGER: Yeah, we looked at a 900  
24 pound opening, a 1000 pound opening and place in --

25 CO-CHAIR KIRCHNER: Well, I would be

1                   worried about if it opened at 1100 or higher.

2                   MR. INFANGER: Well, that's, the testing  
3                   showed that it always opened between 900 and 1000, so  
4                   we used 1000 as the analytical limit.

5                   CO-CHAIR KIRCHNER: Okay.

6                   MR. INFANGER: It's the highest pressure  
7                   it would open.

8                   CO-CHAIR KIRCHNER: Okay, thank you.

9                   MR. INFANGER: In the LOCA analysis, what  
10                  we're concerned about is the water level above the top  
11                  of the active fuel. And the staggered IAB opening did  
12                  not make a difference in that analysis. The limiting  
13                  case was the IAB releasing at the lowest pressure,  
14                  which was 900 PSID. So that resulted in the lowest  
15                  water level above the top of active fuel.

16                  And in the, for the inadvertent opening of  
17                  an ECCS valve, the change in IAB set point did not  
18                  affect that analysis. The MCHFR occurs when the valve  
19                  opens within half a second of 0.3 seconds, so that it  
20                  happens so quick that the, the staggered in the change  
21                  in the IAB set point was not, did not have any impact.

22                  But since we had redone the analysis, we  
23                  had for other reasons we had made some changes in the  
24                  model, and that did result in a slight change to the  
25                  MCHFR. But again, it was not related to the IAB

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1 change, but it was, we did this calculations over  
2 again, so the change did impact the values in Rev 4 of  
3 the FSAR.

4 CO-CHAIR KIRCHNER: What did drive those  
5 changes?

6 MR. INFANGER: There was, they were pretty  
7 much one was an error correction in flow resistance.  
8 And then there was a conservative reactivity feedback  
9 that we did that was beneficial for reload analysis.  
10 So it was something that we decided that we wanted to  
11 make the change. But then that did impact a little  
12 bit of our market.

13 CO-CHAIR KIRCHNER: Other decision making  
14 and analyses were involved in the reasons for those  
15 changes.

16 MR. INFANGER: Right, and they just  
17 happened to be at the same time --

18 CO-CHAIR KIRCHNER: Okay.

19 MR. INFANGER: As making this change. And  
20 we verified that the 1300 was adequate to ensure that  
21 the ECCS valves remained closed until the reactor  
22 trips, it's one of our acceptance criteria.

23 So as you can see here what the actual  
24 values were. So the one, the containment pressure  
25 design is now 1050 PSIA, and the results went from 986

1 to 994. The minimum water level above the top of  
2 active fuel and a small break LOCA went from 1.7 feet  
3 to 1.5 feet, and that's just the transient condition.  
4 And it goes up to about ten feet after things steady  
5 out.

6                   And we invert an ECCS valve. The MCHFR  
7 limit is 1.13, and the value dropped about 0.09. So  
8 it's a small change to that.

9                   So one of the things that came out of the  
10 audit is we looked at how we were going to do the IAB  
11 testing. So we established, in order to ensure the  
12 safety functions are met, there's a technical  
13 specification that has a surveillance that says to do  
14 the testing in accordance with the in-service testing  
15 program.

16                   We added a section in FSAR 3.9 for an  
17 alternative authorization, which basically shows that  
18 we will for pre-service testing, we will verify the  
19 set points for the RRV and RVVs for all inadvertent  
20 actuation block devices on all of the NPMs. So in the  
21 pre-service they all get tested to make sure they  
22 block at the above-the-threshold pressure and they  
23 open in the release window of 1000 to 900 pounds.

24                   And then after the initial pre-service  
25 testing, they'll be operational testing required by

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1 the tech specs. And for the first refueling of the  
2 first NPM, we're going to do the same tests as the  
3 pre-service test where all the valves are tested. And  
4 then the second NPM refueling, we're going to test one  
5 RRV and one RVV. And subsequent outages are per the  
6 ASME OM code and the mandatory appendix.

7 MEMBER BALLINGER: Now, what if between  
8 the first startup and the first refueling, you have to  
9 shutdown and depressurize? Do you restart the plant?  
10 Do you have to verify that the IAB works? In other  
11 words, do you have to verify operability at each  
12 startup?

17 CO-CHAIR KIRCHNER: Indirectly, you're  
18 going to do a test on each of these towels when  
19 pressurize the primary system. At least you'll know  
20 the upper set point is working.

21 MEMBER BALLINGER: That's true, that's  
22 true.

23 CO-CHAIR KIRCHNER: Just think about the  
24 sequence they have to go through. They've got to pump  
25 down containment, and then you're going to have a

1 differential pressure of, what's your normal operating  
2 pressure, 18 --

3 MEMBER BALLINGER: 1850.

4 CO-CHAIR KIRCHNER: Versus subatmospheric.

5 So you'll at least know the upper end is working.

6 MEMBER BALLINGER: Yeah, but BWRs and  
7 stuff like that with pilot-operated relief valves,  
8 they have to verify operability before they go above  
9 150 psi or something like that when they start up. I  
10 think.

11 CO-CHAIR KIRCHNER: Well, they have to  
12 reset their valves each time.

13 MEMBER BALLINGER: Yeah.

14 MR. INFANGER: And then, I think Dan  
15 mentioned, as Dan mentioned earlier that we will be  
16 doing the functional design and qualification testing  
17 for ASME QME-1 to verify the valves function as  
18 designed.

19 So on the conclusions, what we've, this  
20 change to the IAB range resulted in a containment peak  
21 pressure slightly more limiting, about 8 psi, due to  
22 the explicit evaluation of ECCS opening at different  
23 release pressures. The LOCA minimum water level drops  
24 slightly due to the lower IAB release pressure of 900  
25 pounds.

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1                   The inadvertent ECCS valve opening at a  
2 slightly more limiting MCHFR due to other changes made  
3 to the model but not to the IAB change. All of the  
4 results showed that we had margin to the acceptance  
5 criteria, and that we established pre-service and  
6 operational testing programs to assure that safety  
7 functions are maintained.

8                   Any other questions?

9                   MR. LASSINGER: I might add just another  
10 interjection, you know, explanation of the IAB valve  
11 testing. It's not that, you know, I think maybe  
12 there's an impression that we don't know how the valve  
13 behaves between 1,000 psi and 1,300 psi. We always  
14 expect, and in the test program that we carried out,  
15 the IAB to block around 1,200 to 1,250 psi every time.

16                  You know, like was said, it's a spring  
17 and a disk. It's nothing really complicated going on  
18 there. But it does not block at something less than  
19 1,200 psi. Or, I guess let me say it differently.

20                  Given a block, it won't release until 950.  
21 But, if you start with an initial pressure of less  
22 than 1,200 psi, you know, testing shows that it may  
23 not block, it doesn't block, it won't block below  
24 1,200 psi initial pressure. Even though if it does  
25 block initially it won't release until the 950.

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1                   And, you know, that, I think that's a  
2 nuance. We understand how --

3                   MEMBER MARCH-LEUBA: If I'm sitting at  
4 1,200 psi, how I don't -- if I sit at 1,200 psi for a  
5 week and I will turn the power off the ECCS valve, so  
6 I demand an opening, you're saying it may remain --  
7 what does the IAB valve, the IAB valve moves, or it  
8 fails to move, or is it running?

9                   MR. LASSINGER: At 1,200 psi it's right on  
10 the edge. IAB may not block, and safety analysis  
11 accounts for that fact that may not block.

12                  MEMBER MARCH-LEUBA: So, ECCS would open?

13                  MR. LASSINGER: Right.

14                  MEMBER MARCH-LEUBA: But, if the valve is  
15 blocking --

16                  MR. LASSINGER: But if it does block.

17                  MEMBER MARCH-LEUBA: -- then the valve now  
18 is blocking position. You need to lower the pressure,  
19 otherwise --

20                  MR. LASSINGER: Yes, yes.

21                  MEMBER MARCH-LEUBA: - 950, whatever it  
22 is, otherwise it will not move.

23                  MR. LASSINGER: If it does block it will  
24 not release until that 950 psi plus or minus 50.  
25 That's the delta between which it doesn't block given

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1       an initial pressure to the release given, given an  
2       initial block.

3                    MEMBER MARCH-LEUBA:     So, when it is  
4       blocking, the surface area is different because part  
5       of the surface area is covered, and therefore you need  
6       a higher delta P to produce the same force. Whereas,  
7       if it's not closed you have a larger surface area and,  
8       therefore, your behavior is different. Is that the  
9       mechanism?

10                  You know what I mean, you have this, I  
11      mean, if it's hitting against the surface, and it's a  
12      ring, you do the analysis more.

13                  MR. LASSINGER: It's the surface area is  
14      on the bottom of this bellows of the IAB.

15                  MEMBER MARCH-LEUBA: Those are different,  
16      there are two.

17                  MR. LASSINGER: Right. And so the surface  
18      area is really still the same.

19                  MEMBER MARCH-LEUBA: Okay. I think what  
20      I said, think about it.

21                  MR. LASSINGER: Yeah.

22                  MEMBER MARCH-LEUBA: Is the reason why  
23      this the status is.

24                  MR. LASSINGER: Okay. So, I just wanted  
25      to add that.

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1 CO-CHAIR KIRCHNER: Members, further  
2 questions? Okay, thank you, Paul and Dan.

3 Thank you, Paul and Dan. We will now turn  
4 to the staff. Again, we are in open session. And  
5 we're pretty close to being on time. Thank you.

6 Okay. I am going to turn again to Bruce  
7 Bavol, and he will make an introduction.

8 MR. BAVOL: Okay. My name is Bruce Bavol.  
9 The name of the presentation is The Inadvertent  
10 Actuation Blocked IAB Valve. And it's going to be  
11 discussed from our technical reviewer Tom Scarbrough.

12 Just let me know when you want to change.

13 MR. SCARBROUGH: Okay. Thank you.

14 I'm Tom Scarbrough. I'm currently the  
15 acting chief of the Mechanical Engineering Branch  
16 until a permanent replacement's assigned.

17 Your questions about the IAB valve are  
18 terrific because that is what we asked about when we  
19 first starting looking at this design back in, like,  
20 2017. We started with some initial audits and found  
21 out more about the valve, you know, how it worked, and  
22 what testing they had done to demonstrate it.

23 And from that we went even further and  
24 discussed it with them.

25 So, first of all this is what Dan was just

1 talking about in terms of it's a first-of-a-kind valve  
2 system design, for the emergency core cooling.  
3 There's three reactor vents to the top and two 2-inch  
4 reactor recirculation valves on the side.

5 And each RVV and RRV has a, it's a main  
6 valve, an IAB valve, solenoid valve, and solenoid  
7 reset valve that's connected by small tubing.

8 I'll try to stay away from any numbers,  
9 right, because I don't want to get into proprietary.

10 And during 2019 NuScale conducted ECCS  
11 valve design demonstration testing. And I'll talk  
12 about what that is. And it was intended, it's  
13 intended to satisfy 10 CFR 5247(c)(2) and 50.43(e),  
14 Echo, for this first-of-its-kind design.

15 So, let me show you what are in those  
16 requirements.

17 5247 requires that a DCA that uses a  
18 reactor, has a reactor design that uses passive means  
19 to accomplish functions must have an essentially  
20 complete design and must meet 50.43(e).

21 Now, 50.43(e) is a very long requirement.  
22 But just boiling down to just the main part here, has  
23 to do with if it's a reactor, a passive reactor and  
24 its safety -- means to accomplish its safety functions  
25 will be approved only if the performance of each

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1       design safety feature has been demonstrated -- and  
2       it's not qualified, it's demonstrated -- through  
3       either analysis testing, experience, combination  
4       thereof. And since it's the first time, there was  
5       none of that available.

6                     And there has to be sufficient data to  
7       support any analysis.

8                     So, what I did when we first started  
9       looking at his review was what had NuScale performed  
10      and to support this first-of-a-kind design, and did it  
11      satisfy 50.43(e).

12                  So, I went back to the notice, which is  
13       August 28th, 2007, and in it it talks, the Commission  
14       talks about what it intended regarding this status  
15       finding. Now, it used the term "qualification." But  
16       when you read it, it wasn't reading qualification as,  
17       like, Appendix B to Part 50, that type of  
18       qualification. It was more of a design demonstration  
19       aspect.

20                  And I talked to OGC about it and what  
21       their interpretation was, and we came up with  
22       agreement of what we would expect for them for a  
23       design demonstration aspect.

24                  Okay. So, so what did we do? Okay. We  
25       started our evaluation. We reviewed the design

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1           description BCA. And that was very general, as you  
2           know, it's very general. So, we had meetings with  
3           NuScale. And also we stated conducting audits of  
4           their designs and their design documentation.

5           And part of that was their Failure Modes  
6           and Effects Analysis. We looked through that, looked  
7           through what they assumed were all the possible ways  
8           that this valve system could fail. We had a number of  
9           comments on that.

10           We conducted our initial audit, onsite  
11           audit at Carderock in 2018, in May of 2018.

12           MEMBER BLEY: Excuse me.

13           MR. SCARBROUGH: Yes, sir?

14           MEMBER BLEY: Did they make any changes  
15           from your review of Failure Modes and Effects  
16           Analysis.

17           MR. SCARBROUGH: In the Failure Modes --  
18           yes, they did.

19           MEMBER BLEY: Okay.

20           MR. SCARBROUGH: They went back and --

21           MEMBER BLEY: They agreed with the things  
22           you raised?

23           MR. SCARBROUGH: Yes. Yes. They went  
24           back and modified it in response to we had a specific  
25           audit report on the Failure Modes and Effects

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1 Analysis. And as part of the follow-up they went back  
2 and revised that and expanded some of those  
3 discussions they had.

4 MEMBER BLEY: Okay.

5 MR. SCARBROUGH: Okay. So, in May of 2018  
6 we went to Carderock and looked at what they had  
7 developed so far. And Dan had mentioned that back in  
8 2015 they had conducted what they called proof of  
9 concept testing.

10 It was, it was pressurized water but it  
11 was tap water; right? It was just 70 degree  
12 Fahrenheit water. There was no flashing, no boration,  
13 anything like that. And they indicated based on their  
14 discussions that it worked fine.

15 Now, they didn't have the hydraulic lines  
16 weren't the same length. It was more, it was a proof  
17 concept; right? Do you want to put more money into  
18 this design or do you want to go a different route.  
19 Right?

20 So, based on that we reviewed the proof  
21 concept report. And the conclusion was, yeah, we  
22 think we can span this discuss -- this design. We  
23 can, you know, do more testing, more evaluation. So  
24 that was the conclusion.

25 So, we came back and we look at that. And

1 we talked about the various aspects of that. And  
2 decision of the NRC was that was not sufficient to  
3 meet 50.43(e). You needed to have high temperature,  
4 pressurized water, boration. You needed to show  
5 flashing. You needed to show these things because  
6 you're demonstrating this safety feature. This is the  
7 safety feature of the plant; right?

8 So, so that's what our decision was. We  
9 went back and relayed that to NuScale. NuScale was  
10 very receptive. They understood our concern, our  
11 interpretation of 50.43(e). And that, at that point  
12 they started the more detailed design demonstration  
13 testing that they conducted over the summer. And so,  
14 they conducted that at Carderock on Long Island. And  
15 we were there many times to watch the testing.

Also, back in May of 2018 and in June of  
2019 we had the NRC Vendor Inspection Branch  
participated with us. They actually conducted a sort  
of parallel inspection. While we were there  
conducting our audit, they were conducting an  
inspection of NuScale's oversight of the Carderock  
testing activities. What would happen when they had  
issues, right, when you'd actually find issues.  
Right?

25 And every time they were making sure that

1 Carderock was following the provisions that NuScale  
2 set up for when you have testing issues, how you deal  
3 with them, corrective action, that sort of thing. And  
4 those were successful. There were inspections, Vendor  
5 Inspection were there for that.

6 So, after those sets of audits and such,  
7 our audit report, which is in December '19, 2019, we  
8 reached our status of where we are with the design  
9 demonstration testing to satisfy 5040 -- 5247(c)(2)  
10 and 50.43(e).

11 MEMBER BLEY: Tom.

12 MR. SCARBROUGH: Yes, sir?

13 MEMBER BLEY: You brought up boron.

14 MR. SCARBROUGH: Yes.

15 MEMBER BLEY: And if you get any kind of  
16 leakage of the reactor coolant, in the reports are  
17 heat and boric acid crystallizes, that could really  
18 change how this valve operates. Now, they didn't do  
19 any testing to evaluate that. That sometimes is over  
20 a long period of time.

21 MR. SCARBROUGH: We did, we did -- we  
22 talked to them quite a bit about that.

23 MEMBER BLEY: Did you? Can you tell us  
24 what --

25 MR. SCARBROUGH: And one of the things we

1 talked about was that whenever they shut down for  
2 refueling they flush all those lines. All those lines  
3 have to be completely flushed out with new CVCS water.

4 And so, and then when they shut down  
5 they're going to disassemble --

6 MEMBER BLEY: De-min water without any  
7 boron?

8 MR. SCARBROUGH: Well, actually they have  
9 to, they have to refill it with CVCS borated water.

10 MEMBER BLEY: Borated water.

11 MR. SCARBROUGH: Because they have to  
12 match what's in the rest of the coolant system.

13 MEMBER BLEY: So, the flushing is done  
14 with borated water?

15 MR. SCARBROUGH: Yes. Right, right. Yes.

16 So, but they're going to flush it every  
17 outage as part of the whole process. So that was the  
18 concern we had. That was part of the Failure Modes  
19 and Effects Analysis, you know, what could happen if  
20 you had precipitated boron in your system? Since they  
21 have these actions they're going to take to make sure  
22 they do not have that happen.

23 All right, so --

24 CO-CHAIR KIRCHNER: To follow up on that  
25 one, Tom, that all sounds very good, but if the

1 refueling interval is 24 months -- if I have this  
2 right -- then you're not likely -- that valve system,  
3 and I'm glad you're calling it a system because it  
4 really is, the valve system then is going to sit  
5 stagnant at hot conditions. Let's assume it runs at  
6 full power for 24 months, these valves are sitting in  
7 the hot containment environment, quite a bit different  
8 than a valve sitting up on the top of a pressurizer.

9 So, was there any -- I assume you did, you  
10 mentioned prototypical testing at temperature and  
11 pressure --

12 MR. SCARBROUGH: Uh-huh.

13 CO-CHAIR KIRCHNER: -- with boron in the  
14 water.

15 MR. SCARBROUGH: Right.

16 CO-CHAIR KIRCHNER: But this effect that  
17 Dennis alludes to I think you won't see until the  
18 lines sit there stagnant for a considerable period of  
19 time.

20 MR. SCARBROUGH: Right. Now, they did,  
21 they did have -- stop me if I get to far -- that they  
22 had heat racks; right? So, they made sure that this  
23 was all up to temperature, right, throughout this  
24 entire --

25 CO-CHAIR KIRCHNER: Okay.

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1                   MR. SCARBROUGH: -- testing process. And  
2 part of the discussion was could any of this boron  
3 start to precipitate.

4                   But they'd done analysis to show that  
5 they're going to stay above the precipitation  
6 temperature, the point where it might come out of  
7 solution; right?

8                   So that, that's their, that's what they're  
9 seeing right now.

10                  But, as part of the qualification process  
11 on QME-1, right, it's going to be even more detailed  
12 in terms of looking for things like that. Right?

13                  CO-CHAIR KIRCHNER: Okay.

14                  MR. SCARBROUGH: This is, this was --  
15 this, the intent of this design demonstration testing  
16 is to demonstrate the concept.

17                  CO-CHAIR KIRCHNER: Proof of concept, yes.

18                  MR. SCARBROUGH: Yes. It's an aspect to  
19 demonstrate the physics, that the physics will work.  
20 But they still have to go through all the  
21 qualification testing of QME-1.

22                  And part of what they learned from this --  
23 and I'll mention this later in the slides -- the final  
24 test report has a lot of very good lessons learned  
25 from the testing; right? That they have to, they

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1 indicate they have to fold this into our QME-1  
2 qualification program.

3 And so, part of that is they need to make  
4 sure that they don't have any issues regarding  
5 temperature effects of sitting for a long period of  
6 time. They may have to have testing concepts where  
7 they let it sit for quite a while, that sort of thing.

8 So there's the QME-1 qualification is the  
9 next step. This was to demonstrate the physics, did  
10 it satisfy 50.43(e) in terms of will it, will it work.

11 And based on that, yes, they have  
12 demonstrated that it will work but they still need to  
13 qualify it for its, you know, the entire application  
14 for the valve. And so, that's the next step actually.

15 MEMBER BLEY: When does that happen in the  
16 process?

17 MR. SCARBROUGH: Well, I'm sure they're  
18 going to start soon because they're going to need to  
19 have all of that completed. They'll need to prepare  
20 their qualification plan.

21 We saw a draft while we were there during  
22 our, our audit. But there are other places they need  
23 to update it based on all these lessons learned. So,  
24 what they'll do is -- I understand Carderock's already  
25 working on their, their sort of prototype valves and

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1           cells and that sort of thing.

2                   So, I'm sure as soon as the next step  
3       comes they will start processing this qualification.

4                   MEMBER BLEY: When does it have to be  
5       done, by the COL time or?

6                   MR. SCARBROUGH: Yeah, it -- oh yes, it  
7       has to be completed. There is an ITAAC that's for  
8       qualification.

9                   MEMBER BLEY: So it's an ITAAC?

10                  MR. SCARBROUGH: For QME-1 qualification.  
11       And so they will have to have that completed.

12                  But, as we've done with Vogtle 3 and 4, we  
13       don't wait till the end to close out or review an  
14       ITAAC, especially when it comes to valves. Right?  
15       We, you know, like, we're currently looking at Vogtle  
16       3 and 4 for their qualification of their valves. And  
17       they're not going to start up for quite a while.

18                  MEMBER BLEY: I'm sorry, this doesn't have  
19       anything to do with this one, but so you're getting  
20       ITAAcs completed well before, a year or two before?

21                  MR. SCARBROUGH: We can review them. Or  
22       we could close them out if we wanted to --

23                  MEMBER BLEY: Okay. And you're actually  
24       reviewing, yeah.

25                  MR. SCARBROUGH: -- but we're, we're

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1 reviewing them. RRVs; right?

2 MEMBER BLEY: Yes.

3 MR. SCARBROUGH: Thank you.

4 Okay. As the summary of their, of their  
5 actually their design demonstration testing. So, they  
6 conducted, they used a flow valve, a 2-inch flow valve  
7 that's sort of a mock-up of the RRV. And it was the  
8 same valve they used for the proof of concept 2015.  
9 But they're basically saying it has the same sort of  
10 internal dimensions and such.

11 And so, they had three main test  
12 objectives. They were: demonstrate the main valve  
13 functions at the operating temperatures and pressure  
14 fluid conditions; they wanted to show that the IAB  
15 valve functions at operating temperature and pressure;  
16 and then they had it set up for the IAB valve and the  
17 trip lines will function under the fluid temperature  
18 conditions with the boron.

19 So, they wanted to have -- and a lot of  
20 times when Dan was talking about the IAB valve not  
21 operating properly, a lot of that was in the IAB valve  
22 functionality testing that they saw.

23 So, so the main valve they wanted, you  
24 know, they wanted the main valve to remain closed,  
25 right, until the pressure was reduced to a specific

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1 value and have it open.

2                   The IAB, they wanted it to close quickly.  
3 It sits there open -- like, I'm not going to say how  
4 far it has to sit there open -- but it sits there,  
5 it's open. Right? And it's a seal quickly, very  
6 quickly, within very, very short amount of time.  
7 Right? Has to seal, right, and hold the pressure so  
8 that the pressure for the main valve doesn't bleed off  
9 and allow the main valve to open prematurely. So, it  
10 has all those functions.

11                  And then, and then later as the pressure  
12 drops, so like if it's a real low pressure, the  
13 pressure drops and then the spring will pull it back  
14 open.

15                  So, all that has to happen. So they  
16 wanted to, and then wanted to show that in the IAB  
17 valve they wanted to make sure that the flashing of  
18 the borated water. Because one of our concerns was  
19 when this borated water starts flashing, is it going  
20 to come out and clog up that line and clog that.  
21 Well, they ran a number of tests and they did not see  
22 it happening.

23                  So, you know, based on that, I mean, they  
24 showed it didn't work, i.e., it was kind of guessing  
25 whether or not it would block it or not, but it seemed

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1 to work okay even with the flashing of borated water.

2 CO-CHAIR KIRCHNER: Did you folks get to  
3 observe the test?

4 MR. SCARBROUGH: Yes, absolutely. Yes.  
5 We went there in June and went through a walk-down of  
6 their whole -- their test set-up. We watched them run  
7 the test.

8 Then we went back later again in July to  
9 watch them run the addition of borated water test. So  
10 we, we made sure that we had enough eyes on what they  
11 were doing that we were comfortable with the whole  
12 process.

13 MEMBER SUNSERI: And that sequence of  
14 events or that, all that work is well documented --

15 MR. SCARBROUGH: Yes.

16 MEMBER SUNSERI: -- in the audit report?

17 MR. SCARBROUGH: Yes. My audit report is  
18 probably one of the longest audit reports you've ever  
19 seen.

20 MEMBER SUNSERI: Yeah.

21 MR. SCARBROUGH: But it's --

22 MEMBER SUNSERI: Well, not the longest but  
23 it's a good one.

24 MR. SCARBROUGH: Yeah. If you look at the  
25 -- I put the ADAMS number right here. And you can

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feel free to look at it. I mean, we want to make sure  
that in the future if there's another reviewer picking  
this up that they'll have the whole story.

4 MEMBER SUNSERI: Yeah. It's in ADAMS,  
5 your report.

6 MR. SCARBROUGH: It's in ADAMS, yes, sir.

All right. So, they tested. Test  
conditions were saturated steam, cold water, nominal  
temperature water. And the pressure range went all  
the way from 30 to 1850 psi. And so, they had a whole  
series. And as they mentioned on the phone, you know,  
there were three for each set of tests; right? So,  
they had three runs to show that it was set.

14                       Okay. All right. So, the test results.  
15                       Right.

16                       Okay. So, in August they reported that  
17                       the testing had been completed. But the test revealed  
18                       that certain aspects of the original valve system  
19                       design did not perform as expected. And that's some  
20                       stuff that Sam was talking about.

Like, for example, when the IAB valve, one  
of the issues was the IAB valve did not close; right?  
It was supposed to close at a certain pressure, and it  
didn't close, right? And so the main valve opens  
immediately. Right? It loses all its pressure and it

1 just opens. So, that's not a good thing; right?

2                   Another time the main valve did not open  
3 at all; right? The IAB valve shut; right? And then  
4 when the IAB valve later reopened, the main valve  
5 still stayed closed, which is not a good thing.  
6 Right? And because they have to get the max  
7 circulation going; right?

8                   And so --

9                   MEMBER SUNSERI: Did they, did they want  
10 to close that?

11                  MR. SCARBROUGH: Yes. It has to do with  
12 it's very important in terms of its rate, right.  
13 What's going on is your -- the pressure is being  
14 relieved, right, and there's an orifice in the main  
15 valve disk that's feeding from the reactor. So, you  
16 have to bleed out this line.

17                  That's one of the reasons why we were very  
18 interested in what would happen with the flashing in  
19 the borated water because you have to bleed out that  
20 fast enough to be able to drain that, that main  
21 chamber to get that pressure out of there, you know,  
22 to allow the main valve to open like it's supposed to  
23 at the right pressure. Right?

24                  So, so that was one of the things that  
25 they found, you know, from their issue.

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1                   So, so the design changes -- and I won't  
2 give any numbers because that's all proprietary -- but  
3 they had to reduce that main valve control chamber  
4 orifice diameter; right?

5                   MEMBER SUNSERI: Uh-huh.

6                   MR. SCARBROUGH: They had to reduce the  
7 IAB valve portlet because there's, there's between the  
8 main valve and the IAB valve there's a port going  
9 through there. And that port needs to be the right  
10 size to be able to bleed that pressure off at the  
11 right rate to be able to have the main valve operate  
12 properly. And so they had to adjust that.

13                  MEMBER MARCH-LEUBA: If the problem was  
14 this drain orifice was this much, then it will never  
15 open.

16                  MR. SCARBROUGH: Yes.

17                  MEMBER MARCH-LEUBA: It never did open?

18                  MR. SCARBROUGH: Well, yes.

19                  MEMBER MARCH-LEUBA: Or was it one time,  
20 a random fail?

21                  MR. SCARBROUGH: No. What happened with  
22 the main valve not opening was it just eventually it  
23 opened. Because there's a small spring in the main  
24 valve that tries to open it; right?

25                  MEMBER MARCH-LEUBA: That's when you get

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1 to 100 Psid.

2 MR. SCARBROUGH: Yeah, right. So, yeah,  
3 that's right. It's very, very small.

4 MEMBER MARCH-LEUBA: Yeah, that wasn't  
5 opening.

6 MR. SCARBROUGH: It's very small. But,  
7 yeah, eventually that little spring opened it. Sure.

8 MEMBER MARCH-LEUBA: But it all failed.

9 MR. SCARBROUGH: Yeah. So they, so they  
10 needed to adjust all that relationship.

11 And then the last change there is the  
12 valve trim. Because we talked about set points, but  
13 there really aren't any set points in this valve, it's  
14 a design valve; right? They, they established the  
15 spring time, the spring rate of how much load the  
16 spring's going to provide by a shim in the design;  
17 right?

18 It's not something like a normal release  
19 valve, you can go out and do the rings and adjust  
20 them; right? So, you know, and actually that's one  
21 point we've asked them to make. If you looked at the  
22 latest version of the Rev 4, they go through and they  
23 take out places where they set checkpoints; right?  
24 Because it's kind of misleading.

25 They use the word checkpoints when they're

1 talking about this type of valve.

2 CO-CHAIR KIRCHNER: It's hard wired.

3 MR. SCARBROUGH: Yes, it's hard wired.

4 Right. It's part of the design. Right.

5 CO-CHAIR KIRCHNER: Part of the design.

6 MR. SCARBROUGH: You can't, unless you  
7 pull the thing off and disassemble it, you cannot  
8 adjust where that spring is going to go.

9 MEMBER PETTI: Is the valve in a high  
10 radiation field?

11 MR. SCARBROUGH: Yes. Yes, well, yes,  
12 it's sitting -- well, it's a valve system so it's  
13 sitting -- but the valves are sitting on top of the  
14 reactor vessel or on the side of the reactor vessel.  
15 So, yes, it's very high.

16 MEMBER PETTI: I mean, I just worry about  
17 the spring constant change. It's on, yes. The spring  
18 constant changing because of VPA on the steel changing  
19 its modulation.

20 MR. SCARBROUGH: Yes.

21 MEMBER PETTI: So, it's, you know, it's K.

22 MR. SCARBROUGH: Right. Right. And  
23 that's, and that's one that arised the first time they  
24 shut the plant down, right, because you can't really  
25 operate this during the plant operation, they're going

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1 to pull all five of those IABs off and test them for  
2 their press -- you know, the release pressure and  
3 threshold pressure. And if they see any changes  
4 they're going to have to adjust it.

5 They might if they see, if they see  
6 differences they're going to have to go in and maybe  
7 do mid-cycle outages or something like that. But  
8 that's the first, that's the first thing they're going  
9 to check: is there something like that happening to  
10 these springs?

11 MEMBER PETTI: Some sort of aging effect,  
12 --

13 MR. SCARBROUGH: Yes.

14 MEMBER PETTI: -- if you will.

15 MR. SCARBROUGH: Right. Right. And so  
16 that's something they're going to have to look into.

17 Now, what they did was -- and as Dan was  
18 talking about, in the original DCA it was 1,100 Psid  
19 plus or minus 100. And they determined that that was  
20 not possible. So now it's basically 1,100 plus or  
21 minus 200.

22 But, as Dan was kind of telling you, the  
23 wording in the DCA is more complicated than that. I  
24 won't read it, but it has to do with 1,300, and 950  
25 plus or minus 50. So, but just from a slide

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1 perspective it's roughly that.

2 So, then they also had to do one of the  
3 things we asked them about was, okay, how does the RVV  
4 operate, right, because that's a 5-inch valve, right.  
5 So they tested the 2-inch. So, they need to relate  
6 that.

7 So, in their final test report they went  
8 through and talked about the discharge volumes and how  
9 that would be different. And they calculated, you  
10 know, the short time differences that might occur from  
11 that. And they did run some tests with steam which  
12 would be the RVV condition.

13 So, based on that they were able to show  
14 that from a physics perspective, you know, that they  
15 demonstrated from the 50.43(e) perspective that this  
16 was a reasonable extrapolation of the testing.

17 So, they still have to do the QME-1  
18 qualification testing of the RVV.

19 Okay.

20 CO-CHAIR KIRCHNER: One valve set sits in  
21 a different environment than the other. The RRVs are  
22 going to be sitting in a steam environment. The RVVs  
23 are going to be sitting in a water environment.

24 MR. SCARBROUGH: Well, no, actually all of  
25 them are --

1 CO-CHAIR KIRCHNER: Oh, I misspoke. Maybe  
2 I got it --

3 MR. SCARBROUGH: Well, no. The --

4 CO-CHAIR KIRCHNER: The RV on the top --

5 MR. SCARBROUGH: Yes. Those are RVVs are  
6 on the top.

7 CO-CHAIR KIRCHNER: But the RRVs on the  
8 bottom and they'll sit in a water environment.

9 MR. SCARBROUGH: Not normal. Only if an  
10 accident occurs.

11 CO-CHAIR KIRCHNER: Only in the accident.

12 MR. SCARBROUGH: That's what kills. Yeah,  
13 they'll be sitting there just in the containment, you  
14 know, sort of environment.

15 CO-CHAIR KIRCHNER: No, what I meant was  
16 the valve seat is sitting in a water environment.

17 MR. SCARBROUGH: No. No, it -- No, that  
18 area won't be wet. It will still be dry.

19 CO-CHAIR KIRCHNER: No, I'm talking about  
20 the valve that's on the inside.

21 MR. SCARBROUGH: Oh, on the inside.

22 CO-CHAIR KIRCHNER: Yes. That's going to  
23 sit in a water environment, and it's hot. And it's  
24 been in a hotter environmental --

25 MR. SCARBROUGH: Yes.

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1 CO-CHAIR KIRCHNER: -- situation than  
2 upstairs in the, where the RVVs.

3 MR. SCARBROUGH: Right, right.

4 CO-CHAIR KIRCHNER: And the RVVs are going  
5 to be sitting in a steam environment, which is more  
6 typical of the target rod valve on a pressurizer.

7 MR. SCARBROUGH: Right. So, you know,  
8 these are sort of typical flow valves, yes. So,  
9 you're right, they'll -- that one at the RRVs will be  
10 sitting down below. Right.

11 CO-CHAIR KIRCHNER: There's two on the  
12 bottom.

13 MR. SCARBROUGH: And they'll have that  
14 water temperature.

15 So they're going to have to evaluate that  
16 as part of the qualification testing to demonstrate  
17 that from that specific application they won't have,  
18 you know, leakage issues and such with that seat  
19 sitting there.

20 CO-CHAIR KIRCHNER: I worry less about  
21 leakage than it's just welding itself in position.

22 MR. SCARBROUGH: Well, it's --

23 CO-CHAIR KIRCHNER: And "weld," I use that  
24 word loosely.

25 MR. SCARBROUGH: Yes. Yes. Yes.

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1 CO-CHAIR KIRCHNER: The boron environment,  
2 hot conditions, radiation field, the valve sits into  
3 its seat and doesn't open.

4 MR. SCARBROUGH: Yeah, they're going to  
5 have to look at that as part of qualification that  
6 it's going to set there for a while under that  
7 environment; right? So they're going to have to  
8 qualify it for the conditions.

9 CO-CHAIR KIRCHNER: There will always be  
10 testing for leakage.

11 MR. SCARBROUGH: Uh-huh.

12 CO-CHAIR KIRCHNER: They've got a tech  
13 spec on there. And they won't be able to keep a  
14 containment vacuum if they're leaking any significant  
15 amount.

16 MR. SCARBROUGH: Yes.

17 CO-CHAIR KIRCHNER: So, that part of worry  
18 less about.

19 I worry more about the valve functioning  
20 and opening --

21 MR. SCARBROUGH: Right.

22 CO-CHAIR KIRCHNER: -- on demand.

23 MR. SCARBROUGH: Yes. That's a very good  
24 point. So, we'll make sure that that's part of their  
25 qualification because they're going to have to make

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1       sure that they qualify it for those conditions and  
2       they don't have an issue with the boron valve in it.

3                   CO-CHAIR KIRCHNER: Right.

4                   MEMBER BALLINGER: I forget, what's the  
5       seat and disk material?

6                   MEMBER PETTI: I was going to ask you that  
7       same question.

8                   MR. SCARBROUGH: Oh.

9                   MEMBER PETTI: It's all, it's all, the  
10      whole thing is all stainless steel. Right? The disk  
11      material that will all be stainless steel material.

12                  MR. SCARBROUGH: Maybe NuScale can help us  
13      with the exact material.

14                  (Simultaneous conversation.)

15                  CO-CHAIR KIRCHNER: Go ahead, Dan.

16                  MR. LASSINGER: There's a hard facing weld  
17      build-up for the seat and the disk. Or, I'm sorry,  
18      excuse me. Only for the seat, not for the disk. The  
19      disk is the 16 stainless steel.

20                  MEMBER BALLINGER: I didn't get it.

21                  MR. LASSINGER: It's a hard facing.

22                  MEMBER BALLINGER: We couldn't hear him.

23                  CO-CHAIR KIRCHNER: You're soft-spoken.  
24      You'll have to say it again, Dan. Speak louder.

25                  MR. LASSINGER: The disk -- excuse me, the

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1       seat of the valve, of the main valve is a welded hard  
2       facing. It's not stellite, it's a no-rem, which has  
3       no cobalt. But the disk is a 316 stainless steel  
4       material.

5                    MR. SCARBROUGH: Okay.

6                    MEMBER BALLINGER: Okay.

7                    CO-CHAIR KIRCHNER: Thank you. Thank you,  
8       Dan.

9                    MR. SCARBROUGH: Okay. So, I mentioned  
10      the final test report that came, and we looked at  
11      that. And there were a number of key observations  
12      from the report. And some of, Dan mentioned some of  
13      these in his presentation, was the ratio of inflow and  
14      outflow for the main valve it's critical to have the  
15      main valve open properly. Right? So, that was one of  
16      their lessons learned or key observations.

17                  And also the IAB valve threshold and  
18      release pressures are impacted by room temperature.  
19      This whole flashing effect causes the valve. That's  
20      why it's so complicated to come up with the parameters  
21      for the IAB valve.

22                  MEMBER BLEY: Tom, can you clarify that  
23      first bullet for me? When you say inflow and outflow  
24      you're talking about into the ports that connect up  
25      with the IAB?

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1                   MR. SCARBROUGH: Right, yes. The main,  
2 the main valve has an orifice that communicates with  
3 the reactor coolant system.

4                   MEMBER BLEY: And that's the input and the  
5 output?

6                   MR. SCARBROUGH: Yeah, it is inflow trying  
7 to fill up that chamber. And when you want it to open  
8 you have to evacuate that main chamber faster than  
9 what the reactor coolant system is trying to resupply.

10                  And if the pressure in that main chamber  
11 doesn't get down to a certain percentage, I won't say  
12 it, just a certain percentage of the reactor coolant  
13 system pressure, it won't open. You know, so it has  
14 to be relieved off.

15                  Yes, so that's where that -- that's where  
16 that comes from.

17                  And so, and then also, as we talked about,  
18 the port that feeds from the main valve into the IAB  
19 valve, that port is very important. And to get the  
20 IAB valve to open and close you have to, you have to  
21 remove that pressure out of there so that the IAB  
22 valve can perform its function.

23                  MEMBER BLEY: We didn't ask NuScale but  
24 from I'm certain the tests, if this, these two were  
25 found to be really important did they have to change

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1 anything in the design of those --

2 MR. SCARBROUGH: Well, yes. Yeah.

3 MEMBER BLEY: -- to make it work?

4 MR. SCARBROUGH: Right, right. Remember,  
5 on the previous slide I was talking about they had  
6 made those changes to the main valve control chamber  
7 orifice diameter.

8 MEMBER BLEY: Okay.

9 MR. SCARBROUGH: The port inlet diameter,  
10 the shim set. All those things --

11 MEMBER BLEY: That all came out of the  
12 tests?

13 MR. SCARBROUGH: Yes, yes.

14 And then there's, as Dan was talking  
15 about, there's, because there's a IAB valve trying to  
16 operate under flashing conditions and such in 2-phase  
17 flow, it's hard to come up with a very specific  
18 parameter in terms of its opening and closing  
19 pressure; right? As you all were talking about, it  
20 has to, you have to have enough oomph, right, for it  
21 to get it to seal because it has to seal immediately  
22 first time. Right.

23 And so, because it has to hold, all five  
24 have to hold, right, because if you lose one,  
25 eventually they're all going to open because you're

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going to be losing, right, pressure in your reactor coolant system. So, they all have to seal. And so you have to have enough pressure force from the reactor coolant system to overcome that spring to get it to seal tightly.

6                           And so that's why they weren't able to  
7 come up with a very sort of simple plus or minus.  
8 It's more complicated than that.

9                   All right, so those were the lessons, the  
10          report's conclusions.

11 So, so in the audit report that we wrote,  
12 so based on our audit we found that the testing  
13 revealed that they needed to modify the valve design  
14 and the performance assumptions. The lessons learned  
15 need to be incorporated into the QME-1 standard  
16 qualification. All these things we've talked about  
17 were excellent, good ideas you provided you to us.

18 And then, also, the in-service testing  
19 provision. And let me -- I talked to you about the  
20 in-service testing is on the next slide.

21 So, so what has to happen is the DCA has  
22 to be modified to include -- and that's what you see  
23 now in the draft Rev 4 that may have already bene  
24 issued as Rev 4 -- they have to update the DCA. They  
25 have to update design documents, which is why the

1 design documents that include the internal orifice,  
2 shim sizes, things like that, that all has to be  
3 updated. We reviewed the previous versions and they  
4 all, all those have to be updated.

5 So, and then the COL holder will need to  
6 address all these lessons learned, right, and that's  
7 going to actually be happening probably soon, right,  
8 because you still want to have this all taken care of.  
9 So, they'll probably be developing this, you know, in  
10 the relatively near future.

11 MEMBER SUNSERI: Excuse me, Tom.

12 MR. SCARBROUGH: Yes?

13 MEMBER SUNSERI: The COL, the COL  
14 responsibilities are to assure that testing and  
15 qualification of the valve is appropriate? When you  
16 say --

17 MR. SCARBROUGH: The QME-1 qualification.

18 MEMBER SUNSERI: In terms of the lessons  
19 learned?

20 MR. SCARBROUGH: Yes. Because they're  
21 going to have to satisfy the ITAACs which have QME-1  
22 qualification requirements listed with them. And so,  
23 as the process gets closer --

24 MEMBER SUNSERI: Right.

25 MR. SCARBROUGH: -- to building the plant,

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1       they're going to have to have all these valves  
2       qualified. So, they have to go through the  
3       qualification process.

4                    MEMBER SUNSERI: The elements of what  
5       needs to be done that needs to be integrated into that  
6       program and meets the ITAAC?

7                    MR. SCARBROUGH: Yes.

8                    MEMBER SUNSERI: In other words, this is  
9       -- as opposed to the others where NuScale has already  
10      done a lot of work to get it modified, this is, this  
11      is somewhat new?

12                  MR. SCARBROUGH: Yes. Yes.

13                  MEMBER SUNSERI: In other words, has to be  
14      developed and the it has to reflect the lessons  
15      learned.

16                  MR. SCARBROUGH: Yes, exactly.

17                  MEMBER SUNSERI: Okay, thank you.

18                  MR. SCARBROUGH: So, anyway, once we  
19      address the follow-up items we'll reach a conclusion  
20      on whether or not they satisfy 5247(c)(2) and  
21      50.43(e).

22                  MEMBER BLEY: Tom.

23                  MR. SCARBROUGH: Yes?

24                  MEMBER BLEY: This catalog of things they  
25      learned from the valve manufacturer who has been doing

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1       this for a long time, and the combination of sitting  
2       there for a couple of years without being touched,  
3       what's your level of confidence that, you know, after  
4       a couple years these things are going to work the way  
5       they've been tested?

6                    MR. SCARBROUGH: Well, we're --

7                    MEMBER BLEY: And will that be covered in  
8       the qual?

9                    MR. SCARBROUGH: Well, they're going to  
10       have to have qualification that shows that over a long  
11       period of time they don't see this type degradation.  
12       That's going to have to be part of their whole process  
13       in terms of thinking about qualification.

14                  And then when they, they start the plant  
15       up, right, they're going to run, you know, 2 years and  
16       then they'll pull it off, right. And if any of these  
17       valves don't still match their threshold and release  
18       pressures they're going to have to rethink how they  
19       conduct this entire process. They might have to shut  
20       down and do something.

21                  MEMBER BLEY: These things are very  
22       delicate. And, you know, we saw in the last time when  
23       we saw, you showed pictures of the valves --

24                  MR. SCARBROUGH: Yes.

25                  MEMBER BLEY: -- how, how precise

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1 everything --

2 MR. SCARBROUGH: Yes.

3 MEMBER BLEY: -- has to be to work right.

4 MR. SCARBROUGH: Yes. Yes. And I think  
5 that's what happened here with their testing when they  
6 found, you know, they had to make design changes.  
7 Because everything is so fine in terms of the  
8 dimensions and stuff.

9 Yeah. So, but qualification to me will  
10 provide sufficient qualification support that they  
11 could install the valves. And it should be sufficient  
12 to show that over a good period of time they do not  
13 have this sort of problem.

14 Because they could run this test because  
15 they could pressurize it and have it sit there, right,  
16 and then come back, you know, you could have a good  
17 time later, right, and then and run the tests to make  
18 sure it still works properly. So, they're going to  
19 have to think about that.

20 MEMBER BLEY: If that stuff is still  
21 occurring.

22 MR. SCARBROUGH: Yes.

23 MEMBER BLEY: I asked NuScale in previous  
24 meetings and today what led them to worry so much  
25 about inadvertent operation of the ECCS valves that

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1       they'd go to this complex arrangement to avoid the  
2       problems. From a regulator's point of view can you  
3       answer that question for me?

4                    MR. SCARBROUGH: Well, you know --

5                    MEMBER BLEY: Did you drive them to this?

6                    MR. SCARBROUGH: Well, the regulations are  
7       very clear, right, in terms of --

8                    MEMBER BLEY: Well, let me, let me tell  
9       you where I'm coming from.

10                  MR. SCARBROUGH: Okay, sure.

11                  MEMBER BLEY: Back in the '60s and '70s we  
12       had reactor trip breakers. And our regulators at the  
13       time decided we want that to be passive. And they  
14       made all of the operating plants disconnect the shunt  
15       trips on those breakers from PRAs that were then back  
16       then predicted that we're going to have some SCRAM  
17       failures because of that because the shunt trip is  
18       much more effective than just the dropout of power.

19                  And sure enough, we did. And then we  
20       changed our regulatory approach on these things.

21                  I'm wondering if we're driving ourselves  
22       into a spot here that we should have -- I don't know  
23       where the biggest risk is. And I think that  
24       likelihood of inadvertent operations is probably  
25       pretty darn small. And I don't know if we're

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1 challenging our ECCS system unnecessarily.

2 MR. SCARBROUGH: Well, I agree with that  
3 thought. I mean, we've had issues like that, you  
4 know, in my other life, where we'd operate valves with  
5 some overloads; right? We always told everybody to  
6 bypass it from overloads.

7 MEMBER BLEY: Yes.

8 MR. SCARBROUGH: And valves died trying.  
9 Right? And we found that that wasn't such a good  
10 idea.

11 MEMBER BLEY: Not such a good idea.

12 MR. SCARBROUGH: Yeah. So, so and here  
13 because of the way the current regulations are, they  
14 are required by the regulations to assume that any  
15 non-safety related power supply is not available.

16 Now, they could have come in and asked for

17 --

18 MEMBER BLEY: For an exception.

19 MR. SCARBROUGH: -- some exception.

20 MEMBER BLEY: And started elsewhere.

21 MR. SCARBROUGH: Right. And so they could  
22 have come in and asked for something like that.

23 And, actually, in looking at their proof  
24 of concept reports and such, they had various designs  
25 that they were thinking about. Right? This is the

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1       one they came up with. Right? But they could have  
2       come in and asked for some type of, you know,  
3       exemption, or exception, or something.

4                 And, yeah, because I, I agree. You know,  
5       there is some risk involved here because you do want  
6       this valve eventually to reopen. And you don't want  
7       this, this main, this IAB to close and then something  
8       happens that the main valve wouldn't open.

9                 So, yeah, I think there's --

10                MEMBER BLEY: They're hanging on that.

11                MR. SCARBROUGH: I agree with your  
12       concern.

13                MEMBER MARCH-LEUBA: And I would like to  
14       reinforce my colleague's opinion.

15                MR. SCARBROUGH: Uh-huh.

16                MEMBER MARCH-LEUBA: We are supposed to be  
17       moving into risk-informed regulations. And we have  
18       here a regulation that in my opinion, and this isn't  
19       going away, that this is against regs, I mean it's  
20       bad. It wasn't for the IAB and certain parts --

21                MR. SCARBROUGH: Yes.

22                MEMBER MARCH-LEUBA: -- and it can only  
23       get in the way.

24                MR. SCARBROUGH: Yes. And there were  
25       other ways that you could have looked at this from,

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1 you know, a perspective, but this was the way they  
2 came up with because that's what we were reviewing.

3 MEMBER MARCH-LEUBA: I'm not against risk-  
4 informed regulation. I think that we should use it  
5 properly.

6 MR. SCARBROUGH: I agree.

7 MEMBER BALLINGER: I think I heard that  
8 the reasons for this is inadvertent ECCS valve  
9 operation with respect to CHF. Is that what I heard  
10 right?

11 MEMBER BLEY: Assuming electric power goes  
12 away because of not one -- even though it's been  
13 certified as highly reliable by the staff, which  
14 they've defined.

15 MEMBER MARCH-LEUBA: I mean, multi-power.

16 MEMBER BLEY: My prediction is sometime in  
17 the next 5 years we're going to revisit this.

18 MEMBER MARCH-LEUBA: Look at it, the first  
19 time we tested the valve by the manufacturer which has  
20 been building this valve for 50 years, it didn't work.

21 MEMBER BLEY: It didn't work the way they  
22 planned.

23 MEMBER MARCH-LEUBA: No. It didn't, it  
24 didn't open. It didn't open period because the holes  
25 were the wrong size. So, the testing in the facility

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1 didn't work.

2                   Well, they make it a little bigger and  
3 then, woo, now it works, woo.

4                   MR. SCARBROUGH: That's right.

5                   CO-CHAIR KIRCHNER: To wrap up some of  
6 what you were doing, Tom, the qualification program,  
7 that becomes an ITAAC, and that's a COLA  
8 responsibility.

9                   MR. SCARBROUGH: Yes, yes. There is an  
10 ITAAC which says that all the valves, and these are  
11 some of them, have to be, you know, qualified, you  
12 know, demonstrated. And in the Tier 2 section of the  
13 DCA it talks about QME-1 is a process that's going to  
14 take place to meet that. So, that's what they're  
15 going to have to do.

16                  And so they're already thinking about how  
17 they're going to do that.

18                  So, in terms of the audit, what solid  
19 guidance we have is, one, we have to have the IST  
20 program updated in DCA because, you know, what we were  
21 talking about was these valves, these IABs sit there  
22 in the open position all the time; right? And when  
23 they go to shut the plant down they're planning to  
24 lower pressure; right. So, the IAB valve never  
25 operates, right, when they're shutting down. Right?

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1 And so, because, you know, why, why have  
2 a high pressure and then force the valve to perform  
3 its function to stop a high pressure situation. So  
4 they're going to lower pressure down. And the IAB  
5 valve will just sit there; right? So, it will never  
6 have been stroked.

7 Well, the owned code, right, ASME owned  
8 code says that every valve has to be stroked  
9 quarterly, unless you can't do it quarterly, then you  
10 do it every refueling outage or full shutdown.

11 And so, which means that they would, every  
12 time they shut down, they have to take all five valves  
13 off on the bench and test them, all five. So, what  
14 they did was they came in with an alternative request  
15 under 50.55(a)(z) to say, okay, we'll do all five for  
16 the first module for pre-service testing. We'll show  
17 they all work properly.

18                   Then, for the first time we shut down for  
19                   a refueling we'll pull all five out and we'll show  
20                   that they all work in the right amount. If they all  
21                   do, then the next time would be a sampling of one RVV  
22                   and one RRV. Right?

23                   But, if they ever have any failures,  
24   they're going to have to go back and rethink that  
25   whole process; right? If one of them doesn't operate

1       within that range that they have, they have to go back  
2       and rethink that entire process. Right?

3                   CO-CHAIR KIRCHNER: Is that on a module  
4       basis or 12 module basis?

5                   MR. SCARBROUGH: Well, the first one, for  
6       the first module would be --

7                   CO-CHAIR KIRCHNER: All five valves.

8                   MR. SCARBROUGH: All five.

9                   CO-CHAIR KIRCHNER: One module.

10                  MR. SCARBROUGH: Right. And then, and  
11       then after that it would be a sample on whatever  
12       module it is. Right? But for pre-service they all  
13       would be done; right? But then for each module for  
14       the refueling they would do one.

15                  But then because they're under mandatory  
16       Appendix 4 of the code, it has a performance  
17       assessment test schedule where they can show once they  
18       have -- because they're going to have 12 modules,  
19       there's quite a bit of data, they might be able,  
20       hopefully, be able to show that, yeah, there's been no  
21       change on this over time, right, and we'll be able to  
22       kind of lengthen these out. Right?

23                  But for right now the request is that they  
24       would do this sampling. And once they do it the first  
25       time it's for all five. So, that's the request.

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1 MEMBER SUNSERI: You say that as if it's  
2 something new. Isn't that the fundamental a risk-  
3 informed IFP program works?

4 MR. SCARBROUGH: Well, you could, you  
5 could request a risk-informed IFP program. The only  
6 code has risk-informed aspects to it. But when it  
7 comes to the quarterly stroke time testing, it's just  
8 a pure requirement. It's deterministic. And that's  
9 why they're going to come in and ask -- they come in  
10 and ask for this alternative to include this PRA risk-  
11 -informed aspect to it. That's, that's the  
12 difference.

13 Okay. So, all right, so we'll do that.  
14 That's item one.

15 Then we'll have item two in which they  
16 have to update the DCA for all the performance  
17 requirements. And then they have to update all these  
18 design documents for all the modifications they made,  
19 or if there's just a shim placed. Okay?

20 All right. So, so where are we right now?  
21 Okay. So, in October last year they submitted a  
22 letter with the status of what they are doing. And  
23 one of it is a discussion of the updated Rev 4 which  
24 has the new working for the IAB valve parameters.

25 Then in November they sent a letter which

1 included the proposed alternative for the IFP program.  
2 And we're going to be reviewing that as part of the  
3 next phase of the SBR.

4                   And then once they notify us that all of  
5                   the other items have been completed we'll, we'll  
6                   follow up with that and decide how much we need to  
7                   look at that. It may be very simple, just to make  
8                   sure that they updated all these documents.

9 So, then when we get to that point, during  
10 the next phase we'll reach the conclusion regarding  
11 whether or not they satisfy 5247(c)(2) and 50.43(e).  
12 And then, and then we'll be done.

13                   And then what we're doing, we'll be sort  
14                   of monitoring what the plan for, you know, the COL  
15                   stage at that point, where we're going to go from  
16                   there.

17                   But it's been a very interesting review.  
18        You know, I've enjoyed it, you know. I think, I think  
19        we demonstrated that the original proof of concept  
20        testing was not sufficient because of all the design  
21        changes they had to make based on the testing they did  
22        under actual conditions.

23 So, I think it was the right decision that  
24 we made that they needed to do extra testing. And  
25 now, now they're sort of close to where they have

1       actually real design that meets 50.43(e). And once  
2       they start conducting their qualification testing  
3       they'll have to show that it operates under the more  
4       extensive conditions of a qualification project.

5                     CO-CHAIR KIRCHNER: So just so I  
6       understand or we, not me, but the committee and for  
7       the record, when you say the next phase, that's we are  
8       scheduled to complete our review by the June time  
9       frame. You're talking about when you write up the  
10      final SER --

11                  MR. SCARBROUGH: I had --

12                  CO-CHAIR KIRCHNER: -- in September or  
13       summer or?

14                  MR. SCARBROUGH: Yes. Yes, sir.

15                  CO-CHAIR KIRCHNER: Is that --

16                  MR. SCARBROUGH: Yeah.

17                  CO-CHAIR KIRCHNER: -- what you mean by  
18       the next phase?

19                  MR. SCARBROUGH: Yes. Yeah, we're sort of  
20       in phase 5 now because we're briefing you.

21                  CO-CHAIR KIRCHNER: Right. In phase 5.

22                  MR. SCARBROUGH: And phase 6 is when I, I  
23       take all these items and I close it all out in the  
24       SER.

25                  MEMBER BLEY: But the qualification

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1 testing won't have been done yet?

2 MR. SCARBROUGH: No. No. That's going to  
3 be the process for the COL, you know, process as we go  
4 forward, yes.

5 MEMBER BLEY: Tom, I want to thank you for  
6 a very good presentation. And I just starting your  
7 audit report. It's very interesting.

8 MR. SCARBROUGH: Oh, thank you.

9 MEMBER BLEY: I wish we had seen that a  
10 little earlier. But, yes.

11 MR. SCARBROUGH: Well, great. You know,  
12 if you have any questions or follow-up, I'll be happy  
13 to come back and talk to you, you know, as a group or  
14 individually, however you'd like to do it.

15 CO-CHAIR KIRCHNER: Members, further  
16 questions?

17 Dennis, any more?

18 I'll echo Dennis' comment. Thank you for  
19 your thorough presentation. And I like the way you  
20 keyed it up as a system because that's really what  
21 we're dealing with here.

22 MR. SCARBROUGH: Right.

23 CO-CHAIR KIRCHNER: And a very interest  
24 one --

25 MR. SCARBROUGH: Yes.

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1 CO-CHAIR KIRCHNER: -- at that.

2 All right, thank you.

3 MR. SCARBROUGH: Thank you.

4 CO-CHAIR KIRCHNER: We are scheduled now  
5 to take a break. Mike, we're a little bit behind  
6 schedule but not bad.

7 Can I ask that you come back at 10 of  
8 4:00. That's a quick 10-minute break. Thank you.

9 So, we are in recess.

10 (Whereupon, the above-entitled matter went  
11 off the record at 3:38 p.m. and resumed at 3:50 p.m.)

12 CO-CHAIR KIRCHNER: We'll reconvene.

13 Marty, am I going to turn to you again?

14 MR. BRYAN: Yes, sir.

15 CO-CHAIR KIRCHNER: Okay. We're getting  
16 familiar.

17 MR. BRYAN: Yes.

18 CO-CHAIR KIRCHNER: Please.

19 MR. BRYAN: This is the last one. Marty  
20 Brown. This is Chapter 8. And then, Jeff Ehlers is  
21 going to take us through it. Ours is pretty short,  
22 pretty straightforward. We'll be happy to entertain  
23 any questions, but this should get us back on  
24 schedule.

25 So, with that, I'll turn it over to Jeff.

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1                   MR. EHLERS: Yes, we only have two slides  
2 here to present, but the majority of the time is an  
3 opportunity to write, ask any questions. We're not  
4 covering any new material here. This has been  
5 discussed before at a previous meeting.

6                   Just a reminder, I'm the Electrical  
7 Engineering Supervisor at NuScale. So, I own the DC  
8 system.

9                   This is a high-level refresher. The DC  
10 system is not a safety-related system. The design of  
11 it was based on the NRC-approved Topical Report. And  
12 so, we went through the conditions of applicability  
13 for the system design to show that it could meet the  
14 needs that we needed to meet. And this was also  
15 further discussed in Chapter 1 of the Safety  
16 Evaluation Report, what didn't meet the Topical  
17 Report.

18                  In Chapter 8 of the DCA, to make it  
19 convenient, we did provide a table, sort of a Rosetta  
20 Stone. It showed where in the DCA, so someone didn't  
21 have to go through and find all the pieces scattered  
22 throughout the chapter of where we addressed the  
23 Topical Report items in the DCA. That's in Table  
24 8.3-9 in the DCA and, also, Table 8.3-10 shows the  
25 cross-reference for the EDSS Augmented Provisions.

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1                   So, that's basically the list of the brunt  
2 of the presentation for you, but I am happy to take  
3 any questions you have at this time for me.

4                   MEMBER REMPE: So, I have a question.

5                   MR. EHLERS: Okay.

6                   MEMBER REMPE: I was looking through your  
7 Topical Report, and I'm paraphrasing based on my  
8 memory.

9                   MR. EHLERS: Okay.

10                  MEMBER REMPE: So, if I say it wrong,  
11 correct me. But, basically, you talk about, yes, we  
12 aren't going to have -- even if we don't have power  
13 for instrumentation, it's okay because we don't have  
14 to have any operator actions. But we have concerns  
15 about defense-in-depth, and that's why we think it's  
16 good to have those measurements. And I guess I'm not  
17 sure I agree with that philosophy, especially when we  
18 talk about the things we've talked about today. I  
19 think for post-accident monitoring, it would be good  
20 to know whether valves are open or not.

21                  But if I look at Chapter 20, and Table  
22 20.1-1, it talks about that you need to have these  
23 parameters to assure the cooling function is  
24 established, and then, it's good to have it for post-  
25 accident monitoring. Could you elaborate about, if

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1 you were to lose power, why suddenly is there this  
2 kind of disconnect between Chapter 20 that says you've  
3 got to have assurance that the cooling function is  
4 initially established if you don't need power? I  
5 mean, there seems to be a disconnect. Do you  
6 understand my concern?

7 MR. EHLERS: Yes, I think I understand the  
8 question you're asking. So, I think some of the  
9 confusion comes in some of the IEEE guidance  
10 associated with PAM variables and what the  
11 requirements are for safety-related power for them.  
12 So, there's really kind of two parts to it, which is,  
13 one, this is information that operators need to assess  
14 the plant and, two, this information will be used for  
15 them to go take operator action based on some  
16 procedure, or whatever.

17 Now, for Type B and C variables, for the  
18 NuScale design, we say, yes, we have these variables  
19 so the operators can assess the status of the plant,  
20 but the second condition of that is not met because  
21 there are no operator actions to take as a result of  
22 that. So, we didn't meet both conditions to need the  
23 safety-related power.

24 So, what we did say, we still think it's  
25 good for the operators to understand what's going on.

1 So, we provided an augmented design to help prevent  
2 the loss of those indications. That is really the  
3 EDSS's function, is to make sure that they have power  
4 for the PAM instrumentation.

5 MEMBER REMPE: I get that that part is  
6 consistent.

7 MR. EHLERS: Yes.

8 MEMBER REMPE: But what seemed a little  
9 inconsistent is, if I look at Chapter 20, in that  
10 table they talk about the post-accident monitoring,  
11 but, then, they have a column that says, yes, you need  
12 to have the parameters to assure that the cooling  
13 function is established initially. And will you have  
14 that capability if you lose power?

15 MR. EHLERS: To ensure?

16 MEMBER REMPE: That the cooling function  
17 is established initially. It seems like you need it  
18 initially, and then, okay, afterwards there's no  
19 operator actions. But it seems like the initial time,  
20 and then, what do I do if I don't have the power?

21 MR. EHLERS: So, I'm not aware of the  
22 Chapter 20 statement you're talking about. But what  
23 I do know is that there are no operator actions. So,  
24 this might be the use of the words to say it's  
25 necessary for them to know the status of the plant,

1       but there's still no operator actions associated with  
2       that information.

3 MEMBER REMPE: That's true. That's what  
4 I'm getting.

5 MR. EHLERS: Yes.

6 MEMBER REMPE: But why do they need to  
7 know then? I guess I'm going further. I mean, it  
8 kind of sounds like, why bother having that in Chapter  
9 20 saying that you want to establish initially? If  
10 there's no operator actions, why put that in there?  
11 It's a little inconsistent. I think you would want  
12 the operator to know, and that's been a problem with  
13 a lot of accidents that have occurred, is the  
14 operators don't have a way to monitor it. I mean, all  
15 throughout this Topical Report and other places in the  
16 DCA they've emphasized no operator actions are needed.  
17 But, yet, why is it in Chapter 20, in this particular  
18 table, they have that the operator needs to establish  
19 that the initial cooling or determine that the initial  
20 cooling has been established, function has been  
21 established?

22 MR. EHLERS: Like I said, we could  
23 probably follow up to figure out why we put that in  
24 Chapter 20 for you, but --

25 MEMBER REMPE: I think, yes, it seems a

1 little distant.

2 MR. EHLERS: I think the answer is the  
3 same, but I think we'll have to do a follow up as to  
4 exactly why it was put in there.

5 MR. BRYAN: Yes, it's a good question. I  
6 think we understand the question. I've got several  
7 people trying to give me an answer, but I would prefer  
8 to try to sort it out --

9 | (Laughter.)

10 MEMBER REMPE: Well, the reason why is  
11 that I've been involved in looking at Chapter 20 for  
12 the meetings that are going to occur later this week.  
13 But I saw that after I had been preparing for this  
14 meeting. I was a little curious because it seemed the  
15 one place that you've guys weren't quite consistent.

16 MEMBER BLEY: Yes, I agree it's not a  
17 consistent thing. But, back when we reviewed the  
18 Topical on electric power, we really thrashed about  
19 this quite a bit and kind of agreed that, given the  
20 highly reliable electric power they put it instead of  
21 1E, we would have what we needed for PAM in almost all  
22 conditions. And the staff had argued that same thing.  
23 So, we bought into it at that point.

24 MEMBER REMPE: I understand.

25 MEMBER BLEY: And now, there's an

1 inconsistency problem that affects Chapter 20.

2 MEMBER REMPE: There's an inconsistency if  
3 we're going to be talking Chapter 20. It's just I was  
4 maybe amused by it. And I thought I'd bring it up  
5 today because this is such a short presentation.

6 MEMBER BROWN: If you go back and read the  
7 -- that's the EDSS I think you're talking. That's the  
8 highly reliable when you're referring to --

9 CO-CHAIR KIRCHNER: Yes, that's correct.

10 MEMBER BROWN: If you go back and read  
11 under the conditions and limitations and  
12 applicability, they go through a list where the EDSS,  
13 you could call it 1E if you wanted to, but they don't  
14 bless it that way. I mean, you have to meet all the  
15 typical requirements. But do they get an exemption  
16 that says they don't need it because you don't have to  
17 do anything? So, it's still they're building pretty  
18 reliable stuff. And I mean, we really did beat this  
19 horse to death, if I remember correctly.

20 CO-CHAIR KIRCHNER: On that topic, in  
21 preparation for this meeting, we had a teleconference  
22 with NuScale and the staff on electrical systems on  
23 Thursday, January 16th. And one thing we learned, I  
24 think it was following some questions from Dennis, is  
25 that there is an internal engineering report on the

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1       reliability of your system. That was something that  
2       we hadn't had access to.

3                  Do you want to say a few words about that,  
4       Jeff? I thought it would have shown up on your slides  
5       in some manner.

6                  MR. EHLERS: A report concerning the  
7       liability of our design --

8                  CO-CHAIR KIRCHNER: Reliability.

9                  MR. EHLERS: Reliability?

10                 CO-CHAIR KIRCHNER: Yes, estimating,  
11       demonstrating the reliability, an engineering analysis  
12       to demonstrate that it would, indeed, achieve the  
13       highly reliable objectives that are set out.

14                 MR. BRYAN: Yes, I believe you're  
15       referring to the one that we did and the staff audited  
16       for us to do that --

17                 CO-CHAIR KIRCHNER: Yes. Yes. So, I'd  
18       like to just put that on the record. So, could you  
19       say, Marty, for the record, what was done and what the  
20       staff audited?

21                 MR. BRYAN: Well, Sarah, do you want to  
22       address that? Or someone?

23                 MS. BRISTOL: Yes, I'm here. This is  
24       Sarah Bristol.

25                 And I think we did an engineering study

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1 that looked at a typical warning system at an existing  
2 plant, and then, compared that to the NuScale EDSS  
3 highly DC power system and showed that the systems  
4 were equivalent in reliability. And then, the staff  
5 had taken a look at that in one of their audits.

CO-CHAIR KIRCHNER: And we'll ask the staff the same question. Because it was my feeling, at least, when I read Chapter 1 of the SER, that it was more just the statement, repeating a statement that it is highly reliable, almost ipso facto. But, then, we learned that there was actually some engineering analysis that would support that claim. But that doesn't come through in either the FSAR and/or the FSER, or at least this reader did not get that impression that it had been demonstrated.

16 MEMBER DIMITRIJEVIC: And my question is  
17 a little broader than this highly reliable system. I  
18 just have a general question. I brought it up, also,  
19 in these discussions. I completely have no issue that  
20 this is like a normal 1E Class system. There's a PRA.  
21 However, I do have an issue if this is considered not  
22 risk-important non-safety system, because those  
23 systems can be completely forgotten in any of these  
24 Tech Specs, user testing, and things like that. And  
25 usually, those systems, in several NEI documents are

1       considered to have a reliability four times more. I  
2       know that you are not applying 5069 and it's a risk-  
3       informed application, but I think that there should be  
4       some measures which make sure that this system is  
5       performing its function. It means that you cannot  
6       take this generator and keep it all year out of  
7       service, I mean and things like this.

8                 Because, even this system, it did not show  
9       up. That shows you the PRA is not -- it should never  
10      be just a number. That system shows it is not safety-  
11      significant because it doesn't satisfy Dr. Vasily  
12      (phonetic) and weak risk measures. But, at the same  
13      time, looking at the action to start charging systems  
14      shows significant because these guys are higher  
15      affiliated, so it satisfies Dr. Vasily (phonetic).

16               So, with regard to the action to start  
17      charging these risk-significant, then charging has to  
18      be risk-significant, because it actually cannot be  
19      performed without charging, right? Any of the  
20      charging is risk-significant, and the life system also  
21      has to be important, because if you don't have a life  
22      system, the operator cannot start charging.

23               So, we cannot play these number games that  
24      we claim that something is not risk-significant which  
25      is risk-significant. That's why I was sort of more

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1 interested in how this risk significance of the  
2 systems was calculated. Then, I have a billion  
3 questions in the common cause, but I decide this is  
4 not a question about the importance measure. It's a  
5 question, how do you determine that it's a significant  
6 system? And if that system supports important  
7 operator action, then it has to be significant. So,  
8 therefore, I think there should be some measures to  
9 make sure that that system is available and operable.  
10 That's my point.

11 MEMBER BLEY: I don't know if NuScale is  
12 going to tell us anymore. And the staff used a  
13 slightly different approach on this. When we wrote  
14 our letter, we actually said we didn't think it was a  
15 useful exercise. And the real reason we said that is  
16 there is no typical 1E electric power system.

17 Back in the eighties, NRC had a program  
18 -- I think it was called IREP -- and they were trying  
19 to do a generic PRA for PWRs and for BWRs. And the  
20 idea was things that were really plant-specific you  
21 would build models for those systems, but things that  
22 were in all of them, we would have a single model that  
23 would work for everybody. And after trying that, we  
24 found out electric power systems and ultimate heat  
25 sink service water systems -- at that time, there were

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1       50 different plants; there were 50 different systems.  
2       It wasn't a single system. So, I don't think it's  
3       very useful.

4                   But I think what the staff did might be  
5                   helpful because they took a more not reliability  
6                   analysis, but kind of bounding approach to it,  
7                   although they didn't tell us a whole lot about it.  
8                   Maybe they will today.

9 CO-CHAIR KIRCHNER: You thought you were  
10 going to get off easily with two slides, didn't you?

11 | (Laughter.)

12 Members, any other questions or comments?

MEMBER REMPE: Just to follow up, Table  
20.1-1, it's called "Core Cooling Parameters," and it  
lists the functions such as RCS inventory control,  
reactivity control. And for each of those functions,  
it lists between two and four parameters that are  
required to assure that the function is established.  
And there is a footnote, "By design, once these  
functions are established, they're maintained  
indefinitely." And again, that's why I was puzzled,  
because if you go to the third column, it says,  
"Parameters for assuring the function is maintained,"  
and often they say, "None." So, it's just it seems  
like it's important to know initially, and I don't

1 quite understand that table.

2 MR. BRYAN: Yes, someone's getting me the  
3 same table. So, we're trying to run that to ground,  
4 but I understand the question.

5 MEMBER REMPE: Okay. I'd appreciate an  
6 answer --

7 MR. BRYAN: Yes.

8 MEMBER REMPE: -- because I have to do  
9 some Chapter 20 work this week. Thank you.

10 MR. BRYAN: And the answer to your other  
11 question was, apparently, 13 on the data points.

12 MEMBER REMPE: Oh, 13 data points?

13 MR. BRYAN: Yes.

14 MEMBER REMPE: Thank you.

15 (Laughter.)

16 MR. BRYAN: You're welcome. And  
17 centrifugal is the pump.

18 CO-CHAIR KIRCHNER: Of course. Yes, yes,  
19 of course. Yes.

20 Okay. With that, then, if there are no  
21 more questions from the members, thank you, Marty and  
22 Jeff.

23 And we'll now hear from the staff, please.

24 MEMBER BLEY: Mr. Chairman? Walt?

25 CO-CHAIR KIRCHNER: Yes?

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1 MEMBER BLEY: While they're coming up, on  
2 that phone call, I had said there was a new Topical  
3 Report and we didn't know anything about it. Well, it  
4 turns out the new Topical Report is pretty much the  
5 old Topical Report with a Section A, which is a  
6 transmittal letter; a Section B, which is the SER; C,  
7 which is the Topical and D, which is a summary, or  
8 something like that. So, there wasn't anything  
9 really --

10 CO-CHAIR KIRCHNER: There's no new  
11 information there?

12 MEMBER BLEY: And the things they pointed  
13 out -- the staff will talk about this -- were really  
14 the conditions in the staff SER which they addressed.

15 CO-CHAIR KIRCHNER: Yes.

16 MEMBER BLEY: And instead of calling it  
17 the SER, they called it the Topical, which left me  
18 very confused because I hadn't seen it yet.

19 CO-CHAIR KIRCHNER: Okay. Omid, should I  
20 turn to you to make the introduction?

21 MR. TABATABAI: Sure.

22 CO-CHAIR KIRCHNER: Please.

23 MR. TABATABAI: Thank you. Good  
24 afternoon, Members.

25 We're here today to talk about the way

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1 that NuScale basically addressed all the conditions  
2 and limitations of the Safety Evaluation Report for  
3 Class 1E or Electrical Topical Report in the DCA.  
4 That's the purpose of our briefing today.

Just as a refresher, to talk a little bit  
about the background and timeline. The NRC's staff,  
we issued the Safety Evaluation for the Topical Report  
in June of 2017. We approved the Topical Report with  
six conditions and limitations. We briefed the ACRS  
Subcommittee and full Committee in July of 2017. We  
received your letter and you recommended us to approve  
the Topical Report, but make it only specific to  
NuScale design, not generically to any passive design,  
to all passive designs.

We incorporated your comment, responded to your additional recommendations, and we docketed the approved version of the Topical Report in February of 2018. Because NuScale has incorporated this Topical Report by reference in its DCA, we requested NuScale, in January of 2018, via an RAI, to basically describe how the DCA meets all of the conditions and limitations of the Topical Report-Safety Evaluation.

As a result of your recommendation in your letter, since we made it specific to NuScale design, we originally had six conditions, but the revised SE

1 we dropped one of the conditions that would make it  
2 applicable to generic designs, passive designs. So,  
3 we have only five conditions in the SER. In March of  
4 2018, NuScale responded to the RAI and provided a  
5 markup of the DCA, how they have revised the DCA to  
6 incorporate or to address those conditions.

7 So, in the following slides, we're going  
8 to go through those conditions and describe how we  
9 made our finding in terms of applicability of those  
10 conditions to the NuScale design.

With that, I'm going to turn the microphone to Sheila.

13 MS. RAY: Good afternoon. My name is  
14 Sheila Ray. I'm in NRR, the Electrical Engineering,  
15 New Reactor, and License Renewal Branch.

Based on staff's review of the applicability of the Topical Report to the DCA, staff concluded that the onsite and offsite power systems are non-Class 1E. Staff approved NuScale's exemption request from the requirements of GDC-17 on electrical

power systems.

Condition 4.1 of the Topical Report is to address guidance in Reg Guide 1.155, Appendix A, on the quality assurance of non-safety systems and equipment. The DCA states that an augmented QA program is applied to the EDSS and meets the provisions in Reg Guide 1.155. Since the DCA addresses these quality assurance provisions, staff finds the Applicant has met Condition 4.1 and documented the findings in Chapter 8 of the Safety Evaluation.

12 | Next slide.

Condition 4.2 is to confirm the VRLA batteries and structures are Seismic Category 1, to ensure the batteries will perform as intended.

16 | Next slide.

24 MEMBER BLEY: On your previous slide,  
25 Sheila, you talked about the qualification testing

1 plan. You didn't mention that now, and I didn't see  
2 that directly in the SER. Is that called out in the  
3 augmented requirements table?

4 MS. RAY: Yes.

5 MEMBER BLEY: Okay.

6 MS. RAY: Yes, it's augmented  
7 qualification provisions.

8 MEMBER BLEY: Okay.

9 MS. RAY: It's not a testing plan for --

10 MEMBER BLEY: Because it's just that it  
11 was said to be seismic requalified, there will be  
12 testing done?

13 MS. RAY: It's an augmented qualification.

14 MEMBER BLEY: Okay. That's not complete,  
15 though?

16 MS. RAY: No.

17 CO-CHAIR KIRCHNER: And the COLA action to  
18 demonstrate it meets the Seismic Category 1 --

19 MS. RAY: It's in the design. It's in the  
20 design that it's Seismic Category 1. So, I don't  
21 believe there's a COLA action needed because it's  
22 already in the design.

23 CO-CHAIR KIRCHNER: Okay. I misunderstood  
24 your statement.

25 MEMBER BLEY: And it's in the license

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1 because of this condition.

2 CO-CHAIR KIRCHNER: Yes. Okay.

3 MEMBER BLEY: Yes.

4 MR. SCHMIDT: Okay. I'm Jeff Schmidt with  
5 Reactor Systems. I'm going to cover the last three  
6 conditions.

7 So, Condition 4.3 was basically operator  
8 actions necessary to mitigate a Chapter 15 event. And  
9 the Chapter 15 review concluded that no operator  
10 actions are necessary to mitigate a design basis event  
11 out to 72 hours.

12 Condition 4.4 was evaluate the frequency  
13 of an AOA and actuation of the CCS system is  
14 realistically expected to occur, and show that such a  
15 combination of events is not expected to occur in the  
16 life of the model.

17 MEMBER BROWN: Can I interrupt you just  
18 for a second?

19 MR. SCHMIDT: Sure.

20 MEMBER BROWN: May I, please?

21 MR. SCHMIDT: Sure.

22 MEMBER BROWN: When we say 72 hours, it  
23 effectively means we have to have power back, some  
24 power back in 72 hours. That's the way I read this in  
25 both the TR and the SER, when I read it.

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1 MR. SCHMIDT: Not necessarily. I mean,  
2 it's obviously --

3 MEMBER BROWN: Well, it says they don't  
4 have to, operators don't have to take any actions for  
5 72 hours. That implies you have to have some  
6 capability of taking actions, and I don't think that  
7 means blacksmith hammers and anvils.

8 MR. SCHMIDT: As far as like what happens  
9 after 72 hours, is that what you're --

10 MEMBER BROWN: No, it's after 72 hours.  
11 The statement is they don't have to take action for 72  
12 hours. Therefore, that implies that they have some  
13 means, and you hardly have any means if you don't have  
14 electric power back.

15 MR. SCHMIDT: Right, right.

16 MEMBER BROWN: Okay. That's the way I was  
17 reading this stuff.

18 MR. SCHMIDT: Right, right.

19 MEMBER BROWN: Through all the earlier  
20 meetings as well as this.

21 || MR. SCHMIDT: Right.

22 MEMBER BROWN: And I just never thought to  
23 clarify to make sure I was correct.

24 MEMBER REMPE: Well, in other chapters, I  
25 thought it was mainly that the staff just isn't going

1 to review beyond that point.

2 MEMBER BROWN: No, that's not what it  
3 says. It says they don't have to have power for 72  
4 hours.

5 MR. SCHMIDT: They don't, from a Chapter  
6 15 standpoint, they do not have to have power up to 72  
7 hours.

8 MEMBER BROWN: Up to 72 hours.

9 MEMBER REMPE: But his second corollary,  
10 that they have to after 72?

11 MEMBER BROWN: No, they haven't --

12 MEMBER BLEY: This kind of thing has been  
13 in regulation a long time, and there's an embedded  
14 underlying assumption that in 72 hours you can get  
15 help.

16 MEMBER BROWN: Yes, that's right.

17 MR. SCHMIDT: I think that's more in  
18 Chapter 20.

19 MEMBER BROWN: Even if you bring in  
20 batteries and generators on the back of a truck,  
21 that's power. Okay. It doesn't matter. So, this  
22 whole idea that electric power is not needed, at some  
23 point it is. And if you walk away that it isn't,  
24 that's not the case. I was just trying to make sure  
25 everybody understood that clearly.

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1 MEMBER BLEY: Yes, it may not be the case.  
2  
3 MEMBER BROWN: Well, yes. It's hard to  
4 believe if you had no idea what's going on in the  
plant.

5 MR. SCHMIDT: All right. Next slide.

6 MEMBER BROWN: Thank you.

7 MR. SCHMIDT: Sure.

8 So, 4.4 is what I consider like the  
9 escalation clause. You don't want an AOO to turn into  
10 something worse, kind of a defense-in-depth philosophy  
11 here.

12 CO-CHAIR KIRCHNER: So, Jeff, this is  
13 where I have a little problem.

14 MR. SCHMIDT: Okay.

15 CO-CHAIR KIRCHNER: Chapter 6 defines  
16 -- and it was the Applicant, and your SER just  
17 reiterates what the Applicant states -- that  
18 inadvertent opening of an ECCS valve, and the one that  
19 they're worried about is the recirculation valve --

20 MR. SCHMIDT: Right.

21 CO-CHAIR KIRCHNER: -- is an AOO. Now the  
22 definition of an AOO in 10 CFR 50 is one or more times  
23 in the life of the plant.

24 MR. SCHMIDT: That's right.

25 CO-CHAIR KIRCHNER: So, this is, at least

1 from my reading, it seems to be a contradiction in  
2 Chapter 1 based on what is stated in Chapter 6.

3 MR. SCHMIDT: So, the Applicant chose to  
4 evaluate it as an AOO. I think that's the  
5 distinction. For instance, you were just talking  
6 about the block valves, right?

7 CO-CHAIR KIRCHNER: Yes.

8 MR. SCHMIDT: And it was pointed out that  
9 like spurious signal or operator error could lead to  
10 -- and that is classified, typically, in Chapter 15 as  
11 an AOO event. And that's why they put it in the block  
12 valves. But the expectation is, with the combination  
13 of the block valves, that would prevent that from  
14 occurring in the life of the plant. That's why the  
15 word "realistic" is in there. So, the Applicant chose  
16 to analyze to AOO criteria, but it's not expected to  
17 occur on an AOO frequency.

18 MEMBER BLEY: Jeff, from a regulator's  
19 point of view, if it happens once in the life of a  
20 plant, they must treat it as an AOO, if it's expected  
21 to happen once a month.

22 MR. SCHMIDT: Yes. If it's classified --

23 MEMBER BLEY: The fact that it isn't  
24 there, they can still analyze it as --

25 MR. SCHMIDT: Yes, they can analyze to a

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1 more conservative criteria. And I think I talk about  
2 that a little bit on the next slide.

3 MEMBER BLEY: Yes.

4 MR. SCHMIDT: But, yes, you can go down in  
5 classification, but not typically up. So, does that  
6 answer your question?

7 MEMBER BLEY: I just felt that the SER  
8 wasn't internally consistent or clear on that. Maybe  
9 you might look at the wording again.

10 MR. SCHMIDT: Okay.

11 MEMBER BLEY: It just seemed to me an  
12 inherent contradiction with this particular limiting  
13 condition No. 4.

14 MR. SCHMIDT: So, the keyword in this  
15 condition is "realistic". It's more like a PRA and  
16 not necessarily like an assumption that you would make  
17 in Chapter 15. So, this is more of, like I said, PRA-  
18 based. But they chose to analyze all the events in  
19 Chapter 15 as AOOs, even though I think we could argue  
20 that LOCA is probably not an AOO, right? But they're  
21 analyzing AOO criteria.

22 CO-CHAIR KIRCHNER: Personally, would it  
23 define inadvertent operation of ECCS valve as a LOCA?  
24 I know there are reasons they don't want to go there,  
25 because it seems they want to keep a distance from a

1 large-break LOCA --

2 MR. SCHMIDT: That's right, and this is a  
3 pipe break.

4 CO-CHAIR KIRCHNER: -- in Chapter 15.

5 MR. SCHMIDT: Right.

6 CO-CHAIR KIRCHNER: But, by calling is an  
7 AOO, then you open the door to one or more times in  
8 the life of the plant and inconsistency. And I know  
9 I did read the word "realistic," but I would just ask  
10 you, then, to go back and look at your SERs and --

11 MR. SCHMIDT: And this was in Section 6?

12 CO-CHAIR KIRCHNER: Offline. I can get the  
13 SER.

14 MR. SCHMIDT: Okay.

15 CO-CHAIR KIRCHNER: And it's Chapter 6.

16 MR. SCHMIDT: Chapter 6.

17 CO-CHAIR KIRCHNER: And I'll get you the  
18 page number.

19 MR. SCHMIDT: Okay.

20 So, as we kind of already alluded to,  
21 these are the means of uncontrolled reactor coolant  
22 pressure. That's coolant losses, LOCA, inadvertent  
23 operation of an ECCS valve, which we'll basically have  
24 an operator error or a valve failure, or even a  
25 spurious signal, I probably should have added there.

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1                   And then, AOO coincident with the loss of  
2 the non-safety-related DC powers, we talked about it's  
3 not safety-related. So, on an AOO event, we assume  
4 it's not there in Chapter 15.

5                   Again, LOCA is classified as postulated  
6 accident. Operator error, opening the ECCS valve is  
7 basically prevented by the block valve. Mechanical  
8 failure of the safety-related ECCS valve is not  
9 expected to occur in the lifetime of the plant.

10                  AOA coincident with the loss of non-  
11 safety-related DC power, again, the loss of the highly  
12 reliable non-safety-related DC power is not expected  
13 to occur in the lifetime of the plant, based on the  
14 attributes of the system.

15                  For a longer-term loss of AC power, DC  
16 power is returned long enough that the subsequent  
17 opening of the ECCS valves does not challenge  
18 containment integrity.

19                  Condition 4.5, this is demonstration of  
20 shutdown. They have chosen to use the alternate and,  
21 alternatively, an applicant referencing this Topical  
22 Report may provide justification for NRC review for a  
23 less restrictive condition. As we've discussed many  
24 times, shutdown may not be maintained, assuming the  
25 design basis conditions at or near end-of-cycle

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1       conditions. NuScale provided a less restrictive  
2       condition, demonstrating that the SAFDLs are not  
3       exceeded for a potential return to power with a stuck  
4       rod. This is consistent with SECY-18-0099.  
5       Applicant's Chapter 15 analysis demonstrated that the  
6       SAFDLs are met.

7                    MEMBER BLEY: Is there an SRM associated  
8       with that SECY?

9                    MR. SCHMIDT: There is.

10                  MEMBER BLEY: There is?

11                  MR. SCHMIDT: There is. That's correct.

12                  CO-CHAIR KIRCHNER: One more time, Jeff,  
13       I would look at the SER write up in Chapter 1 there  
14       for this particular condition. You have the word  
15       "stable" in there. A return to criticality and power  
16       is not, personally, it's not stable. Whether it  
17       challenges the SAFDLs or the reactor pressure coolant  
18       boundary is a different matter, but I would hardly  
19       describe that as a stable condition. Your definition,  
20       you, along -- I don't want to reopen the GDC-27  
21       exemption, but I guess I am. But it's really like a  
22       hot shutdown. It's not --

23                  MR. SCHMIDT: I can't remember the exact  
24       number, but in 15.0 we reach a stable condition, and  
25       return to power is considered a safe stable condition.

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You will see that in Chapter 15.

2 CO-CHAIR KIRCHNER: Yes, I saw that. Yes.

3 Uncontrolled return to power is not a stable  
4 condition.

5 MR. SCHMIDT: Well, I mean, when I call  
6 the return to power, I call it -- it is the natural  
7 sequence of events that could occur that will reach an  
8 equilibrium condition. So, we're considering that a  
9 safe stable condition.

10 CO-CHAIR KIRCHNER: I would agree with  
11 you. I'm quibbling on words, Jeff. I would agree  
12 that it doesn't challenge the SAFDLs, or as far as we  
13 know it doesn't, and it doesn't challenge the reactor  
14 coolant pressure boundary. So, it meets the  
15 conditions of a safe shutdown, as you've agreed with  
16 the Applicant. But it's not a stable condition. I am  
17 just quibbling with your words.

18 MEMBER BLEY: Perhaps "equilibrium," as he  
19 just used, would be accurate.

20 CO-CHAIR KIRCHNER: Okay.

21 MR. TABATABAI: Well, this concludes our  
22 presentation. If there are other questions for us,  
23 we'll be happy to --

24 CO-CHAIR KIRCHNER: Could you, Omid, and  
25 your team, talk to the audit of their reliability

1 analysis that came up in the teleconference last  
2 month? I mean, basically, what you found or just,  
3 again, for the record. So, you audited an internal  
4 engineering report that basically went through the  
5 EDSS system to demonstrate that the design was, quote-  
6 unquote, "highly reliable". Is that correct?

7 MR. TABATABAI: We did audit some of  
8 NuScale's documentation, internal documents and  
9 analysis, but I'm not sure whether we did it in the  
10 context of finding the system highly reliable, you  
11 know, putting that label on it or not. But I think  
12 our audit was as part of going through the conditions  
13 of applicability that was part of the Topical Report,  
14 to go through those.

15 But I guess I'm going to need help from my  
16 colleagues who formed that --

17 CO-CHAIR KIRCHNER: Because, for me as a  
18 reader, I felt like it was in your SER rather  
19 circular. *Ipsa facto*, this is a condition of  
20 applicability, and, yes, they meet the condition of  
21 applicability, but the evidence, compared to other  
22 sections of the SER, is not -- you know, this  
23 engineering report, for example, we were provided --

24 MEMBER BLEY: You had a paragraph on their  
25 engineering report, reliability of their system. And

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1 you didn't speak in the language you used a minute  
2 ago, but you did make some conclusions based on your  
3 looking. And it was kind of terse in the SER, and  
4 maybe it can be addressed up here.

5 MR. NAKANISHI: This is Tony Nakanishi  
6 with the PRA Branch.

7 And what we could say is that we looked at  
8 the reliability study in the context of the whole PRA.  
9 That was the primary purpose of that review. But I  
10 guess, in terms of the relevance to this, the  
11 application of the Topical Report, I would say that we  
12 really focused more on the design attributes, the  
13 qualitative aspects of how we find adequate  
14 reliability for the system. So, you know, how it's  
15 protected, independence, redundancy of the system,  
16 programs to monitor, things of that nature. So, in  
17 terms of the quantitative reliability aspect, we did  
18 look at it, but we really didn't focus on that  
19 particular -- you know, for the finding that we had to  
20 make.

21 MEMBER BLEY: After our phone call, during  
22 our phone call, we asked that you particularly address  
23 this one. This was one of the paragraphs in Section  
24 1.4.3.2, and it addressed the provision that they do  
25 a reliability analysis. And you gave your reasons for

deciding it was adequate in there, and I'm trying to find it again. And I was hoping you were going to discuss that. If not, I'll keep looking for it.

4 MS. RAY: I believe it is on page 1-28 in  
5 Chapter 1.

6 MEMBER BLEY: Oh, okay. I'm not quite  
7 there yet. Okay.

8 MS. RAY: We make a note that they  
9 performed a failure modes and effects analysis to  
10 evaluate the reliability. However, staff did not  
11 investigate that reliability because EDDS is a non-  
12 safety system, and we found that they're exempt from  
13 GDC-17. So, we did not investigate further on the  
14 reliability. We just noted that they did a failure  
15 modes and effects analysis.

16 MEMBER BLEY: Okay. I'm going to look  
17 back at it because you did draw some conclusions.

18 MEMBER MARCH-LEUBA: Yes, but, Dennis, the  
19 way it said, I'm thinking -- I always thinking  
20 backwards than anybody else. If you have made the  
21 analytical analysis and found that this is a highly  
22 unreliable system, would that have changed any of  
23 these conclusions?

24 MS. RAY: We don't make any conclusion  
25 that it is highly reliable. We make a conclusion that

1                   it is a non-safety system.

2                   MEMBER MARCH-LEUBA: If you mentioned you  
3                   now know it's highly unreliable, would it change the  
4                   conclusions?

5                   MS. RAY: No. The conclusion is still  
6                   non-safety.

7                   MEMBER MARCH-LEUBA: Yes. That's my  
8                   point, that --

9                   MS. RAY: Which means it is not going to  
10                  be available in an accident scenario.

11                  MEMBER MARCH-LEUBA: That's my point, that  
12                  it's good that it is highly reliable.

13                  MS. RAY: Right.

14                  MEMBER MARCH-LEUBA: And we hope to  
15                  continue to make it highly reliable, but it's not  
16                  needed.

17                  MS. RAY: Correct.

18                  MEMBER DIMITRIJEVIC: But what you're  
19                  talking now is not risk-informed discussion at all  
20                  because you are talking of application to Chapter 15,  
21                  which is the deterministic principle. You don't talk  
22                  about the implication on risk at all. So, how are we  
23                  in a risk-informed area?

24                  MS. RAY: So, our evaluation was following  
25                  the enhanced safety focus review, which focuses the

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1 review on risk-significant and safety-related items.  
2 And for the electrical section, based on those  
3 components that we looked at, then, we did the  
4 deterministic review. And so, since they met the  
5 exemptions, and we granted them the exemptions for  
6 GDC-17, we're not going to look further into the EDSS  
7 reliability. So, we did use some risk information at  
8 the beginning to begin our review, but, then, after  
9 that, it is a deterministic review.

10 MEMBER BLEY: On the page you cited in No.  
11 2, which is the direction to implement a methodology  
12 -- and that came from you folks, I believe -- similar  
13 to following -- compared the reliability of highly  
14 reliable DC systems, that of a typical Class 1E, which  
15 I personally didn't think was a useful thing. You  
16 come down partway through and you say you reviewed the  
17 disposition and found it acceptable because, as you  
18 just said, a failure modes and effects analysis was  
19 performed to evaluate the reliability. Therefore, the  
20 staff finds that the Applicant met that condition of  
21 having done this analysis. So, you did look at it.  
22 And did you evaluate how well they did that analysis?  
23 You know, your statement here is pretty vague.

24 MS. RAY: Correct, and that is because the  
25 failure modes and effects analysis, we did not look at

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1 it in-depth because this is a non-safety system.

2 There's no reason --

3 MEMBER BLEY: Okay. You probably should  
4 have said that here because this gives the implication  
5 that you looked at it and concluded they did it well.

6 MS. RAY: We will take that feedback. I  
7 appreciate that comment. We can try and make --

8 MEMBER BLEY: And there's not a hint of  
9 what you just said, that we didn't look at it  
10 because --

11 MS. RAY: I understand.

12 MEMBER BLEY: -- it's a non-safety --

13 MS. RAY: I understand your comment.

14 CO-CHAIR KIRCHNER: Dennis, I have to  
15 admit I read it the same way. That's why --

16 MEMBER BLEY: The way I did?

17 CO-CHAIR KIRCHNER: Yes.

18 MEMBER BLEY: Yes.

19 CO-CHAIR KIRCHNER: Yes.

20 MEMBER BLEY: It's what it says. That's  
21 why you read it that way.

22 (Laughter.)

23 MEMBER DIMITRIJEVIC: Well, would the DRAP  
24 take care of some of those issues?

25 MS. RAY: I will refer to my colleague.

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1 MR. NAKANISHI: So, the EDSS system is not  
2 in the RAP. But the way we sort of look at this is it  
3 sort of has its own RAP program that's got the  
4 augmented --

5 MEMBER DIMITRIJEVIC: Well, I just have to  
6 correct you. It's not in DRAP as directly put from  
7 the PRA. They have an expert panel. I guarantee you  
8 it is going to make it to DRAP because CVCS operates  
9 that. I mean things are there. So, it has to make it  
10 to DRAP.

11 CO-CHAIR KIRCHNER: But the CVCS system  
12 did not make it the RAP, either.

13 MEMBER DIMITRIJEVIC: No, some of the --  
14 that's possible. It's part of the containment  
15 process --

16 CO-CHAIR KIRCHNER: It was judged to be  
17 not risk-significant.

18 MEMBER DIMITRIJEVIC: No. Okay. Some  
19 part of CVCS is, but not when I look at just the  
20 safety containment isolation part of the system.  
21 However, the CVCS actuation human action was related  
22 as safety-significant. And systems which support  
23 safety-significant actions also had to be treated as  
24 safety-significant. The PRA input is just one part of  
25 DRAP. There is all kinds of other questions they have

1 to respond to when they make finally --

2 MEMBER BLEY: But the point you just  
3 raised --

4 MEMBER DIMITRIJEVIC: It's not just the  
5 PRA.

6 MEMBER BLEY: The point you just raised  
7 ties these back together again. We've been there  
8 before. If that action is important, then the system  
9 must be important. And if the system is important,  
10 then the electric power going to that system must be  
11 important.

12 CO-CHAIR KIRCHNER: Yes.

13 MEMBER DIMITRIJEVIC: So, I think that  
14 electrical system is definitely going to make it to  
15 DRAP. And if it doesn't, something isn't in relation  
16 to --

17 CO-CHAIR KIRCHNER: It's not in there now.

18 MR. NAKANISHI: So, the operator action,  
19 the risk-significant operator actions are addressed  
20 through the operator -- you know, there's a separate  
21 program that looks at risk-significant operator  
22 actions, and they'll be treated accordingly.

23 MEMBER BLEY: But wait. If an action  
24 required this to operate a system, the system has got  
25 to be there or you can't do that operation. These

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1           things are daisy-chained together.

2                   MR. NAKANISHI: No, I'm not necessarily  
3           disagreeing with you. Now, you know, NuScale has  
4           established a Topical Report that determines the risk  
5           significance. So, the risk significance, the  
6           quantitative approach did not lead those systems to be  
7           risk-significant.

8                   MEMBER DIMITRIJEVIC: Right.

9                   MR. NAKANISHI: Now it becomes, like you  
10          said, the expert panel approach. And I believe we  
11          went back and forth on that particular item,  
12          especially CVCS, because you could look at the  
13          cutsets, just forget the numbers, but --

14                   MEMBER DIMITRIJEVIC: Yes.

15                   MR. NAKANISHI: But, you know, everything  
16          relies upon the ECCS. And one thing that will be a  
17          defense-in-depth with that would be a CVCS.

18                   CO-CHAIR KIRCHNER: Especially with  
19          exemption to 27.

20                   MEMBER DIMITRIJEVIC: Twenty-seven, right.

21                   MR. NAKANISHI: So, we went back and forth  
22          with that, and I was not part of that review. But we  
23          accepted their expert panel approach. We audited  
24          their meeting minutes. I believe we talked to their  
25          expert panel members, and we came to a conclusion

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1 || that's not necessary.

2 MEMBER DIMITRIJEVIC: Well, let me ask you  
3 just technically: The DRAP problem, whatever it is  
4 now, in the sense of certification is not finally to  
5 pass the test, too, right? They have to finalize it  
6 after they have expert panel meetings and everything.  
7 And they didn't have that now. So, they cannot  
8 finalize it.

16 MEMBER DIMITRIJEVIC: Well, I thank you.

17 CO-CHAIR KIRCHNER: Members, further  
18 questions of the staff on the EDSS?

19                       Okay. Somehow, miraculously, we've gotten  
20 back close to schedule.

21 So, at this juncture then, we're going to  
22 stop and provide an opportunity for public comment.

23 I thank the staff and NuScale for your  
24 presentations.

25 so, while we're opening the bridge line,

1       is there anyone in the room who wishes to make a  
2       comment? If so, please come up to the microphone,  
3       state your name, and make your comment.

4                    Seeing none, we'll wait for the bridge  
5 line. Okay. If there is anyone on the public line who  
6 wishes to make a comment, please do so. State your  
7 name and make your comment.

I'm just the 5-second rule. I'm not  
detecting any comment. I think we can go on, then,  
and close that bridge line. Thank you, Mike.

11 And we have two pieces of business. The  
12 first thing I want to ask of the members, do you feel  
13 any need to go back into a closed session to ask any  
14 further questions at this juncture?

15                           No? No. Okay. Good. Now we're running  
16 well ahead of schedule.

17                   This part, though, may get us back onto  
18 the schedule. So, discussion. We need to consider  
19 what we would like to hear in a full Committee meeting  
20 on the topics that were presented today. And we're  
21 open to any suggestions as to either things that you  
22 want the Applicant and/or the staff to focus on, on  
23 the topics that we covered today.

24 MEMBER MARCH-LEUBA: Is there a member  
25 missing?

1                   Mike can take notes and email them.

2                   CO-CHAIR KIRCHNER: Yes. I mean, this is  
3 an internal discussion. I just want to hear what you  
4 want to hear or focus on in the full Committee  
5 meeting, given that we won't have near this amount of  
6 time. I think we will have about a half-day to cover  
7 these topics in full Committee.

8                   MEMBER PETTI: I really think only the  
9 steam generator topic. I think we can somehow  
10 close these others with a letter from a respected --  
11 like we closed the chapters.

12                  CO-CHAIR KIRCHNER: Yes.

13                  MEMBER PETTI: We should be able to close  
14 these others, right?

15                  CO-CHAIR KIRCHNER: Yes. Okay.

16                  MEMBER PETTI: I think the steam generator  
17 one requires us to -- when are we talking about?

18                  MEMBER BLEY: March the 5th.

19                  CO-CHAIR KIRCHNER: Yes. We were looking  
20 at the March timeframe.

21                  MEMBER MARCH-LEUBA: Unless we are asking  
22 for original calculations, which I would love to, in  
23 which case it might be April or May, whenever they  
24 have it.

25                  MEMBER PETTI: Well, the real question is

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1       they're doing some other stuff. Does it make a  
2       difference?

3                    MEMBER MARCH-LEUBA: From my point of  
4       view, I find it hard to write a positive letter if I  
5       don't have a stability map.

6                    MEMBER PETTI: No, that's the question:  
7       how close of a --

8                    MEMBER MARCH-LEUBA: A stability map.

9                    MEMBER PETTI: Would delaying a month  
10      help? There's two pieces of this, right? I mean,  
11      there's the stability of the reactor and the stability  
12      of the secondary site. The safety case is based on  
13      the stability of the reactor, and we're not saying  
14      anything on that, right?

15                  MEMBER MARCH-LEUBA: The reactor is  
16      Chapter 15 and the Topical Report. That's done.

17                  MEMBER SUNSERI: So, that's my question:  
18      what's the safety significance of these oscillations  
19      in the steam generator tubes? Are we worried about  
20      creating a containment bypass accident, or what are we  
21      really worried about, other than the instability in  
22      these --

23                  CO-CHAIR KIRCHNER: No, it's not that.

24                  MEMBER MARCH-LEUBA: It's inoperability.

25                  CO-CHAIR     KIRCHNER: Yes, it's

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1       inoperability, but it's also a design issue. To  
2       write, as Pete eloquently stated earlier, without that  
3       instability map, and then, looking at the operation of  
4       the module over the time period, you don't have the  
5       total loading to do your design specification or the  
6       ASME code case. That's a safety issue because the  
7       failure of steam generator tubes would be essentially  
8       an accident.

9                    MEMBER SUNSERI: But the only load that  
10      I'm understanding that they're not showing to be  
11      bounded is the potential for fretting of the tube  
12      against the tube support plate, right? That's one of  
13      several of those, but now with anything else, that  
14      they're all --

15                  MEMBER MARCH-LEUBA: My opinion, with the  
16      operator, they're not going to be able to start the  
17      reactor is the only problem. The turbine is going to  
18      continuously trip whenever they hit 20 percent power.

19                  MEMBER BALLINGER: Yes, but is that a  
20      safety issue?

21                  MEMBER RICCARDELLA: If you can't write a  
22      design specification for the denominator of the steam  
23      generator tubes that has the proper load definitions,  
24      then that's something I think we should be concerned  
25      about. The level of disagreement between NuScale and

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1           the staff on this subject was surprising.

2                   CO-CHAIR KIRCHNER: Yes, it is surprising  
3 because, if you look at the staff's -- if, indeed, it  
4 operates primarily in an unstable mode of the lifetime  
5 of the steam generator, it's not going to make it.  
6 And the safety issue is failure of the steam  
7 generator, which is a primary system breach.

8                   MEMBER SUNSERI: And the proposed failure  
9 mechanism is wear of the tube.

10                  CO-CHAIR KIRCHNER: No, fatigue. No?  
11 Fatigue.

12                  MEMBER RICCARDELLA: They demonstrated  
13 with 100 percent oscillations that they meet the  
14 endurance limits of the tube from fatigue.

15                  MEMBER BALLINGER: Yes, but I'd like to  
16 hear --

17                  MEMBER DIMITRIJEVIC: Yes, but, like Pete  
18 says, that doesn't mean -- and Pete said himself  
19 that --

20                  MEMBER RICCARDELLA: In the tubes, I  
21 haven't seen any analysis of the tube sheet weldings.

22                  MEMBER SUNSERI: Well, that's what I'm  
23 trying to understand.

24                  MEMBER PETTI: If I understood what Jose  
25 said, it's that the experiment has a boundary

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1 condition because of that pump that is not exactly the  
2 same boundary condition that will exist in NuScale.  
3 So, there's always going to be an uncertainty in how  
4 you extrapolate from TF1 and 2, probably 2, to what  
5 you expect in NuScale, the power margin. How that  
6 gets resolved, I mean, then, that may be part of a  
7 whole issue of why the staff thinks one thing and  
8 NuScale this other. I don't know. I haven't been  
9 able to close it and put a bow on it yet.

10 MEMBER DIMITRIJEVIC: What Mark and David  
11 are talking about, though, are probability issues, and  
12 they're not necessarily safety issues. When it comes  
13 to the safety issues, even if they maintain ASME  
14 codes, right, because Pete said every failure he saw  
15 met those codes. That doesn't guarantee there would  
16 not be the fail.

17 We discussed it in the lunch. This could  
18 become a safety issue, if the condition of containment  
19 performance requirement doesn't meet this because  
20 we've got the frequency of the steam generator, it  
21 becomes, let's say, industry level. Probably they  
22 will still need that. I have to look at that. But  
23 it's higher than industry level because of those  
24 issues. That can challenge this safety requirement,  
25 but my guess is it's not really likely to happen

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1 because they had all of these other fires, you know,  
2 high core damage frequencies which will reduce these.

3 They calculated steam generator tube  
4 failure frequency based on some assumptions. We don't  
5 have that work. They just told us. They have a basic  
6 thing.

7 MEMBER BALLINGER: Yes, that's one of the  
8 things I'd like to hear them talk about.

9 MEMBER DIMITRIJEVIC: But this work is  
10 much done before all of this discussion happened. So,  
11 I have a feeling they have very optimistic assumptions  
12 in there, in that report. If they had a more  
13 realistic, it will change their frequency  
14 significantly. How much, I don't know.

15 MEMBER BALLINGER: Yes, but, again, what  
16 saves them, what may save them is that the failure  
17 mode is not first. It's creep collapse.

18 MEMBER DIMITRIJEVIC: Well, see, okay, but  
19 they smartly decide to count that as a failure, as a  
20 leak.

21 MEMBER BALLINGER: Okay.

22 MEMBER DIMITRIJEVIC: Because you don't  
23 what's going to happen when it collapses.

24 MEMBER SUNSERI: All I'm saying is just --  
25 and this is getting closer to my point --

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1 MEMBER DIMITRIJEVIC: Okay.

2 MEMBER SUNSERI: -- if we're going to be  
3 successful in providing advice or judgment on this  
4 design, that's going to be predicated on the safety  
5 case, not some owner risk downstream of whatever.  
6 Okay? It's the safety case for the plant. We only  
7 have a few hours, if that much, at the meeting. We  
8 need to get the staff and the Applicant focused on  
9 those issues, so we can make a judgment there, is my  
10 thought.

11 MEMBER REMPE: So, along those lines, in  
12 March, prior to full Committee week, there's going to  
13 be a discussion of PRA Chapter 15 and some other  
14 topics. Would it not be wise to defer writing this  
15 letter on this topic until we hear that additional  
16 information to see if there is some safety cases?  
17 What I am wondering is, if we write a letter in March  
18 about this, but we learn a lot of stuff at the  
19 beginning of the week, if we're making it more  
20 difficult for ourselves.

21 MEMBER PETTI: To me, I'm still concerned,  
22 the more I think about Jose's point, if the boundary  
23 condition in the experiments that I use to validate  
24 NRELAP are not the same boundary conditions in the  
25 power module, at least another NRELAP calculation with

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1       a bounding condition that's more typical somehow --  
2       does it change anything? I mean, it could be  
3       different, but not have any impact, right? Or it  
4       could be different and have an impact. It hasn't been  
5       addressed. So, that may be something that we can get.

6                    MEMBER MARCH-LEUBA: And you get into the  
7       regulations on what GDC will satisfy. But if we have  
8       a design that we certify and sign our names on it, if  
9       we believe that it cannot possibly work, and I believe  
10      it cannot possibly work, cannot possibly be operated,  
11      I don't want to sign my name on it. I mean, it may  
12      not violate any GDC, but, at the minimum, you need to  
13      tell me how is it going to operate. Is it going to be  
14      unstable below 20 percent? Is it going to be unstable  
15      between 20 and 100? I mean, you need to know that  
16      about your design. How can I certify a design that  
17      you, yourself, don't even know?

18                  MEMBER SUNSERI: So, I think they  
19       acknowledged that there's a potential for flow  
20       oscillations in these tubes, and therefore, that's why  
21       they put these flow restrictors in there. And I'm  
22       pretty confident that, if the ones that they have  
23       aren't sized right away and they learn that through  
24       startup testing of their plant, they won't start up  
25       until they resize them and get them right. I mean,

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1       that's how plants go through construction and startup  
2       testing.

3                    MEMBER MARCH-LEUBA: Or they've just got  
4       a hole and go to a void and the thing breaks.

5                    MEMBER BALLINGER: But, again, what Matt  
6       is saying is correct. We may need to hold our nose  
7       because we're all a bunch of PhDs, at least some of us  
8       think we are, sometimes wrong, but never in doubt.  
9       It's really, does this design have a significant  
10      impact on the health and safety of the public, period?  
11      That's our criteria, right? If the steam generator  
12      doesn't last three years, well, you know --

13                  MEMBER BLEY: But if we believe that and  
14      don't make a strong point of it --

15                  MEMBER BALLINGER: We could say that.

16                  MEMBER BLEY: -- we look as bad as anybody  
17      else.

18                  MEMBER BALLINGER: Yes, we could say that  
19      for sure.

20                  MEMBER DIMITRIJEVIC: Then, we could say,  
21      "We told you."

22                  MEMBER BALLINGER: In the past, when quite  
23      a few of these investment risk things actually  
24      happened, all of a sudden, everybody's investigating,  
25      and it's a big-deal issue throughout the NRC and

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1       everywhere else. It looks like a safety issue at that  
2       point. And if we can't agree on experiments and  
3       calculations, you've got to do something about it, not  
4       just close your eyes and walk away.

5                     CO-CHAIR KIRCHNER: But I think my own  
6       opinion is that the first line is to, as Pete  
7       suggested, do we have the correct information and  
8       confidence in the modeling capability to give that  
9       design specification needed for the code? And that is  
10      at root a safety issue because failure --

11                  MEMBER BLEY: There's a GDC.

12                  CO-CHAIR KIRCHNER: There's a GDC, yes.  
13       So, I think that's the basis, Matt, for having a  
14       safety concern. And then, the actual operability of  
15       the plant, that may not rise to the level of safety  
16       concern, but it should be a concern, and I would  
17       expect that we would comment on that in such a letter.

18                  MEMBER SUNSERI: And I don't disagree with  
19       that. I mean, I understand what you're saying.

20                  MEMBER MARCH-LEUBA: It is my opinion  
21       that, before this meeting, these guys and those guys  
22       were not planning to talk about the methodology that  
23       we are going to use to define the loads. And because  
24       we've been pushing at them, now they say, "Well, we're  
25       going to talk to them about the loads, how to define

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1       them." And this Topical Report we've been talking  
2       about, at the minimum, our letter should say the staff  
3       should get together with NuScale and identify the  
4       schedule -- it doesn't need to be for June -- to  
5       ensure the methodology used to define the loads is  
6       adequate.

7                   Because NRELAP 5 is explicitly forbidden  
8       from being used for this application. The staff SER  
9       says: thou shall not use NRELAP 5 for this. So,  
10      they're violating the law by this.

11                  MEMBER SUNSERI: I've made my point.

12                  CO-CHAIR KIRCHNER: Okay. Others?

13                  So, again, let's just go through quickly.  
14        I think I heard a sense that we had sufficient  
15       information on the turbine missiles. Dennis, are  
16       you --

17                  MEMBER BLEY: I'm not sure we need to do  
18       anything beyond an internal letter on that.

19                  CO-CHAIR KIRCHNER: Okay. And then, I  
20       believe that the IAV, again, looking at it as part of  
21       the system, we will come back to that when we do ECCS  
22       focus area.

23                  MEMBER BLEY: And Chapter 19.

24                  CO-CHAIR KIRCHNER: And Chapter 19, right.

25                  My own recommendation would not be to have

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1       a standalone letter on the IAV, but to wait and do the  
2       focus area and treat it like the system it is, and not  
3       just get focused on the IAV.    Is there agreement  
4       there?    Okay.

5                   Electrical system reliability, an internal  
6       letter?    Do you think?    No?

7                   MEMBER BLEY:   Well, we set this meeting up  
8       on it by an internal letter on Chapter 8.

9                   CO-CHAIR KIRCHNER:   Right.

10                  MEMBER BLEY:   We'll just close it.

11                  CO-CHAIR KIRCHNER:   Okay.    Okay.    And  
12       then, what we just discussed, the steam generator.  
13       So, I'll work with Mike.   I think the request to both  
14       the Applicant and the staff should be focus on this  
15       instability concern as affects providing a design  
16       specification that would be used in the ASME code  
17       submittal.

18                  MEMBER BALLINGER:   Yes, but --

19                  CO-CHAIR KIRCHNER:   And then -- go ahead,  
20       Ron.

21                  MEMBER BALLINGER:   I'm sorry.

22                  CO-CHAIR KIRCHNER:   As well as looking at  
23       the fretting and wear-related issues.

24                  MEMBER BALLINGER:   Yes, but I think, from  
25       my point of view, from me understanding the difference

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between the staff and the Applicant, we sort of understood that there's a big difference as a result of this meeting, but it sort of tumbled that that was the case. It would be nice to have someone talk to us about what is the difference between your interpretation and my interpretation and why, you know, that kind of thing. So, it's a little bit clearer.

9 CO-CHAIR KIRCHNER: The cause-and-effect  
10 aspect.

11 MEMBER BALLINGER: Yes. Yes.

12 CO-CHAIR KIRCHNER: After they figure it  
13 out.

14 MEMBER BALLINGER: Well, maybe they have  
15 to say, "We haven't figured it out." But, one way or  
16 the other, yes.

17 MEMBER MARCH-LEUBA: What about if they  
18 come here in March and they tell us, "We won't be  
19 stable -- we'll be stable about 20 percent," and they  
20 come and tell us, "From 20 to 100, I'm unstable," I  
21 mean completely diametrically opposed position, our  
22 letter has to be, "You guys don't know what you're  
23 doing."

24 MEMBER BLEY: And at that point it ought  
25 to be a letter.

1 MEMBER BALLINGER: Oh, yes, that's for  
2 sure.

3 CO-CHAIR KIRCHNER: Yes, yes.

4 MEMBER BLEY: Before we get to our last  
5 letter saying there's a problem.

6 MEMBER BALLINGER: I think the steam  
7 generator focus area is going to be a letter anyway.

8 CO-CHAIR KIRCHNER: Yes, that was the  
9 intent, that for each of the focus areas, we would  
10 have a letter like we did for source term.

11 MEMBER SUNSERI: I know I was in and out  
12 a couple of times today, and I apologize for that. I  
13 might have missed something. So, let me ask this  
14 question.

15 I mean, even though I understand that  
16 there's a difference of opinion between the staff and  
17 the Applicant, they have both arrived at the same  
18 conclusion, that with the Safety Evaluation, that  
19 there is no safety concern.

20 MEMBER BLEY: On the primary system.

21 MEMBER SUNSERI: On the primary? Okay.

22 MEMBER MARCH-LEUBA: On the GDC, it does  
23 not --

24 MEMBER BLEY: Nobody has challenged that.

25 MEMBER SUNSERI: Okay, but the staff has

1           a concern about the DWOs in the secondary side?

2           MEMBER MARCH-LEUBA: No, we do. I do.

3           MEMBER SUNSERI: So, that's my question  
4           then. We said that there's a big difference, right?

5           MEMBER RICCARDELLA: If I interpreted the  
6           staff's presentation properly, it said that, as far as  
7           these DWOs, it's almost universally unstable in all  
8           operating conditions.

9           MEMBER MARCH-LEUBA: Yes.

10          MEMBER RICCARDELLA: And I don't think you  
11          want to do a code fatigue analysis that says that  
12          you've got this instability happening 100 percent of  
13          the time while the plant is operating. I doubt that  
14          that will survive an ASME code fatigue analysis.

15          MEMBER BLEY: And in the NuScale open  
16          session on this, they agreed they were doing the  
17          methodology to examine it, and they were going to  
18          include wear and fretting. And that's going to take  
19          some time. We haven't seen the plan for that, but  
20          it's in progress. So, you know, we might eventually  
21          just say that has to be complete and get resolved with  
22          agreement with staff, but --

23          MEMBER MARCH-LEUBA: It may be a  
24          confirmatory item for after June. I mean, it doesn't  
25          need to be done in May. But we should issue a

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1 recommendation -- when this thing blows up and it  
2 doesn't work, they're going to come and say, "Well,  
3 you guys approved it."

4 MEMBER DIMITRIJEVIC: Even I was telling  
5 you, not everybody has a safety concern. It's just  
6 that I was thinking that maybe through some safety  
7 concern we can bring it back because we cannot really  
8 -- accountability is not, you know, we cannot truly  
9 continue to discuss this.

10 MEMBER BLEY: So, if we go to the power  
11 uprates, we had a big concern about the moisture  
12 separators, and that turned out to be real. And there  
13 was arguments there that, you know, you shouldn't  
14 worry about that; that's an investment risk thing.  
15 Well, it could link back to other parts of the system.

16 MEMBER SUNSERI: Yes, I'm just asking  
17 questions to seek to understand.

18 MEMBER BLEY: I understand.

19 MEMBER SUNSERI: There's just one more  
20 point here, though. I thought what I heard today,  
21 though, is that, from a staff's perspective, there is  
22 -- maybe I'm not going to use the right language here  
23 -- but there is, essentially, no hold on the design  
24 certification at this point. There may be some other  
25 work and additional things that the Applicant needs to

1 do that goes into this ASME code report that they're  
2 going to inspect later that may hold up the actual  
3 building of the plant. But am I interpreting that  
4 position properly?

5 MEMBER BLEY: I think you've got that  
6 right.

7 MS. PATTON: Yes, it's basically what I  
8 explained earlier. We are having discussions with  
9 them regarding the methodology and the appropriate  
10 licensing process for that methodology, but the ITAAC  
11 itself is what would ultimately have the whole ASME  
12 report and everything. And that's inspection process  
13 and everything.

14 MEMBER BLEY: We have the idea Jose  
15 brought up, and I really support that. This is  
16 complex enough and confusing enough, at least right  
17 now, that a Topical Report to get agreement on how  
18 they're going to go ahead with developing the  
19 methodology is really in line.

20 MEMBER BROWN: How can you put this off  
21 for an ITAAC after a license is complete? I thought  
22 that's what I just heard. Do you understand what I'm  
23 saying? I mean, I'm going back 10 years with the I&C  
24 stuff. There was a big issue on the ITAACs and the  
25 DACs. In other words, there was lists of ITAACs and

DACs all characterized in the licensing, in the DCD,  
in the licensing document. And we eventually said  
that's not going to work. We've got to have a  
framework; we've got to have a design at which you can  
focus the ITAACs and DACs on. And I'm just listening,  
and it doesn't sound like you have a design for the  
steam generators. How do you focus ITAACs on that  
and settle it after the license is approved? That  
seems to me to be a disconnect.

I might be wrong because I, obviously,  
don't know as much about DWO types. It sounds kind of  
fascinating. But fighting is not a good idea, no  
matter what you do. You're trying to figure out a way  
to accept permanent oscillations forever at all power  
levels, and that somehow just, if you say that out  
loud, it doesn't sound real crisp.

17                   This is kind of the same as this thing.  
18        You've got to have a framework or a basis, a  
19        methodology, a Topical Report, something that focuses-  
20        in and says these are the things you have to resolve  
21        to say this is okay. And it doesn't sound like you've  
22        got that, based on listening today.

23 CO-CHAIR KIRCHNER: For me personally, it  
24 feels like a confirmatory item, that the Applicant  
25 demonstrate and the staff accept the analysis that

will eventually inform things like the specification  
for the ASME case.

3 MEMBER BROWN: That would be more  
4 comfortable for me.

5 CO-CHAIR KIRCHNER: I would be much more  
6 comfortable with such an approach, because I have  
7 something of a gut-level feeling this is not something  
8 that's going to be resolved in the next couple of  
9 months.

10 MEMBER DIMITRIJEVIC: Right. No,  
11 definitely not.

12 CO-CHAIR KIRCHNER: I mean, if we're  
13 working on first checking methodology and agreeing on  
14 the methodology is acceptable, and then, you're doing  
15 the analyses, that doesn't sound like a couple of  
16 months to me.

17 MEMBER BROWN: Nobody was talking that way  
18 that I heard.

19 MEMBER BLEY: By the way, if anybody lost  
20 a cover for an Ironkey USB drive, there it sits.

CO-CHAIR KIRCHNER: Okay. We have some  
homework to do, I think, and preparation for the full  
Committee meeting on this topic of steam generator.

Further comments at this point? Anyone  
from the staff wish to make any comment?

1                   Jeff, please. Since we're on record, just  
2 give them your name. He knows who you are.

3 MR. SCHMIDT: This is Jeff Schmidt,  
4 Reactor Systems.

I was asked if there was an SRM on the  
SECY-18-0099 and I said yes. That's incorrect. There  
is not. That was an information-only SECY. So, you  
wouldn't get an SRM on that. So, I just wanted to set  
the record straight. I got confused with the IAV for  
a second there. That's all I have.

11 MEMBER BLEY: How could that be?

12 || (Laughter.)

13 MR. SCHMIDT: There's a lot of SECYS.

14 All right. Thank you. I apologize for  
15 that.

16 CO-CHAIR KIRCHNER: Okay. Thank you,  
17 Jeff.

18 MEMBER BLEY: Thanks, Jeff.

CO-CHAIR KIRCHNER: All right. If there  
are no further comments from members, we are  
adjourned.



LO-0120-68573

January 31, 2020

Docket No. 52-048

U.S. Nuclear Regulatory Commission  
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One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852-2738

**SUBJECT:** NuScale Power, LLC Submittal of Presentation Materials Titled "ACRS Subcommittee Presentation: NuScale FSAR – Steam Generator Design," PM-0220-68568, Revision 0

The purpose of this submittal is to provide presentation materials to the NRC for use during the upcoming Advisory Committee on Reactor Safeguards (ACRS) Subcommittee Meeting on February 4, 2020. The materials support NuScale's presentation of the NuScale steam generator design.

The enclosure to this letter is the nonproprietary presentation titled "ACRS Subcommittee Presentation: NuScale FSAR – Steam Generator Design," PM-0220-68568, Revision 0.

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

If you have any questions, please contact Marty Bryan at 541-452-7172 or at [mbryan@nuscalepower.com](mailto:mbryan@nuscalepower.com).

Sincerely,

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

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**Enclosure:** "ACRS Subcommittee Presentation: NuScale FSAR – Steam Generator Design," PM-0220-68568, Revision 0

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LO-0120-68573

**Enclosure:**

"ACRS Subcommittee Presentation: NuScale FSAR – Steam Generator Design," PM-0220-68568,  
Revision 0

**NuScale Power, LLC**

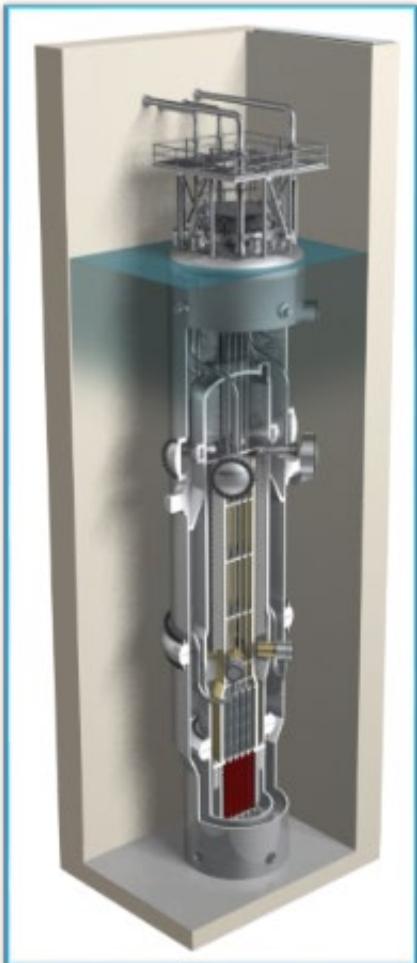
1100 NE Circle Blvd., Suite 200      Corvallis, Oregon 97330      Office 541.360-0500      Fax 541.207.3928  
[www.nuscalepower.com](http://www.nuscalepower.com)

# ACRS Subcommittee Presentation

## NuScale FSAR

## STEAM GENERATOR DESIGN

February 4, 2020



# Presenters

---

**Kent Welter**

Engineering Chief, Testing and Analysis

**Kevin Spencer**

Mechanical Engineer, NSSS Engineering

**Joe Remic**

Supervisor, NSSS Component Analysis

**Brian Wolf**

Supervisor, Code Development

**Marty Bryan**

Licensing Project Manager

---

# Steam Generator Design - Open Session Agenda

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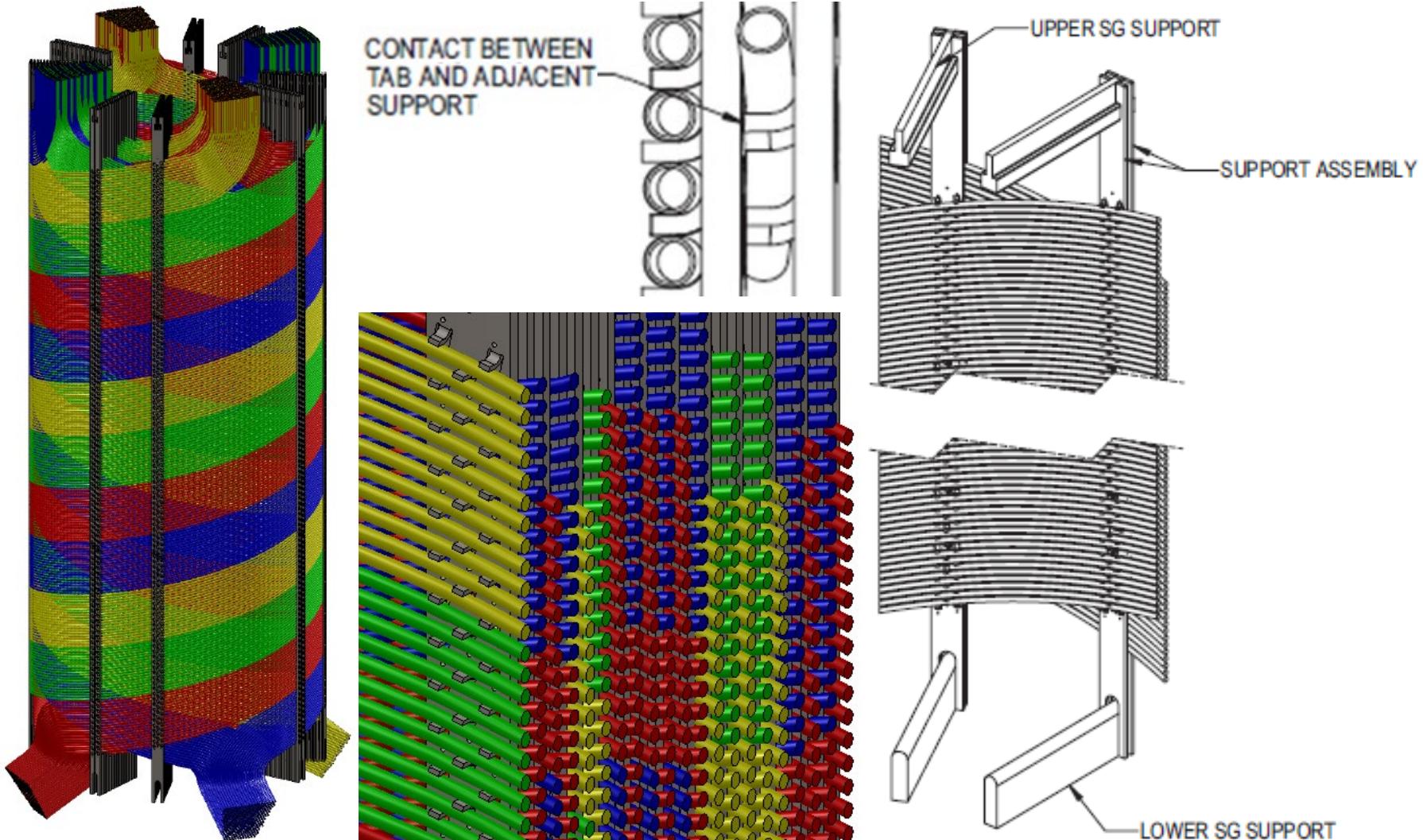
- Steam Generator Design
- Steam Generator Inspection Program
- Density Wave Oscillation Overview
- ITAAC Closure Path for DWO
- Preliminary Scoping Study
- Planned Closure Activities Through ITAAC

# Steam Generator Design

---

- **Integral Helical Coil SG Design features**
  - Shell side is primary side - Tube side is secondary side
  - Alloy 690 TT (1380 tubes, 77 - 87ft long, 5/8" OD)
  - Low flow in primary (~1ft/sec)
  - Tube wall degradation allowance (0.010" > ASME min wall)
  - Support 100% volumetric inspection
  - Normal access to shell side of tubes from below during refueling
- **Incorporation of Operating Experience**
  - Follow guidance of NEI 97-06 & EPRI (COL Item 5.4-1: Develop and implement a SG Program)
- **Flow restrictor design at SG tube inlet ensures acceptable tube flow fluctuations during operation**

# Steam Generator Design (Cont'd)



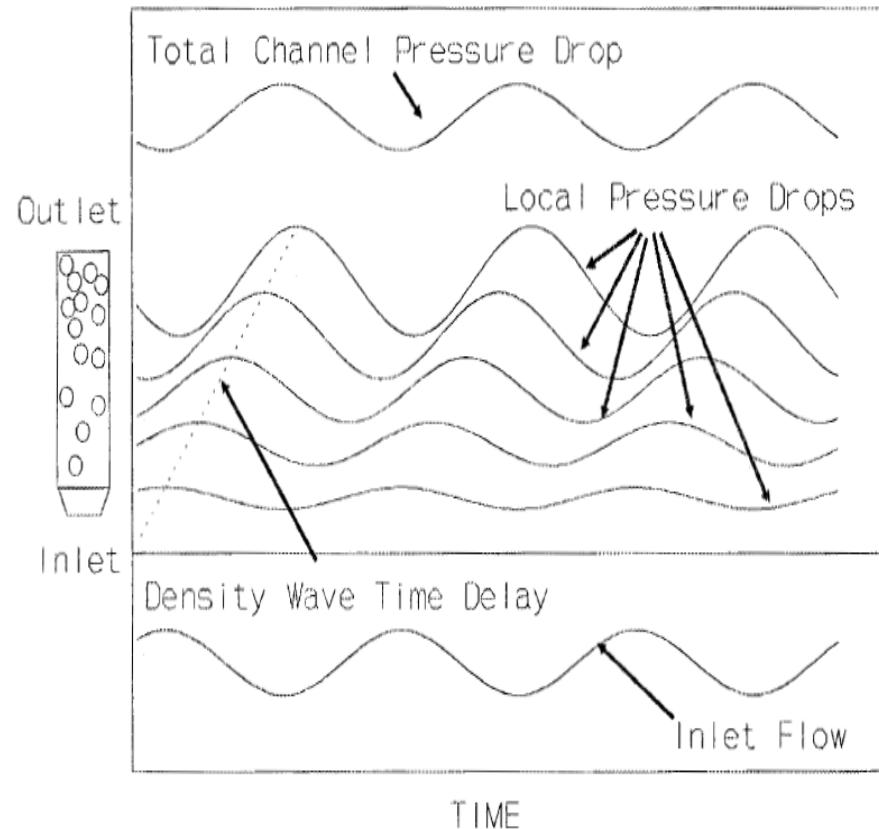
# Steam Generator Inspection Program

---

- Monitors performance and condition of SGs as part of ISI
- Implements applicable portions of B&PV code Section XI and 10 CFR 50.55a(g)
- Appendix B to 10 CFR 50 applies to implementation
- Follows NEI 97-06 and EPRI guidance 1013706 Rev 7 “Steam Generator Management Program, PWR SG Examination Guidelines”
- Includes
  - Degradation assessment (including wear due to fretting)
  - Tube integrity assessment
  - Shell side integrity assessment

# Density Wave Oscillation – Overview

- Consider a case for inlet flow reduction
  - sinusoidal flow fluctuation
- Causes increase in void
- Voids move through the channel
- Voids movement also known as Density Wave Motion
- Density wave produces pressure drop fluctuations
- Pressure drop is delayed with respect to the inlet flow fluctuations
- At certain frequency
  - Total pressure drop is completely out of phase with the flow fluctuations
  - Effectively produces the negative pressure drop
  - Causes flow surge
  - Cycle repeats
- DWO can be self sustaining



(March-Leuba, J., "Density Wave Instabilities in BWR", NUREG/CR-6003, Oct. 1992.)

# Density Wave Oscillation – Overview (continued)

---

- DCA Rev. 3 Section 3.9.1 discusses the possibility of secondary flow oscillations during power ascent and descent
- Section 5.4.1.2 addresses Inlet Flow Restrictor (IFR) sizing to limit DWO to acceptable limits
- The NuScale Stability Topical Report TR-0516-49417 concludes that secondary oscillations do not challenge fuel thermal limits
- Additional review of the DCA language is ongoing and adjustments will be made in a final revision as necessary

# ITAAC Closure Path for DWO

---

- ITAAC 02.01.01 requires that an inspection is performed of the NuScale Power Module “ASME Code Class 1, 2, 3, and CS as-built component Design Reports to verify that the requirements of ASME Code Section III are met”
- Tier 1 Table 2.1-2 defines the NuScale Power Module (NPM) ASME Code Class 1, 2, 3, and CS components:

Equipment Name	ASME Code Section III
RCS Integral RPV/SG/Pressurizer	1

- Therefore, ITAAC 02.01.01 requires the inspection of the certified ASME Design Reports for the RPV and the steam generator

# ITAAC Closure Path for DWO (continued)

---

- Subsection NCA of the 2013 Edition of the ASME Code defines requirements of what is to be included in ASME Design Specifications and ASME Design Reports.
  - Design Specifications
    - NCA-2142.2 requires that Design Specifications identify all loadings (e.g. pressure, temperature, mechanical loads, cycles, and/or transients) and the service limits a component will experience
      - » Loading combinations for the RPV (including SG tubes) defined in Table 3.9-3 of DCA
      - » Transient (TH) loads are based on time history of design basis transients, described in DCA Section 3.9.1.

# ITAAC Closure Path for DWO (continued)

---

- Subsection NCA of the 2013 Edition of the ASME Code defines requirements of what is to be included in ASME Design Specifications and ASME Design Reports.
  - Design Reports
    - NCA-3260 requires that the Design Report evaluate the loads and load combinations as defined in the Design Specification to the applicable acceptance criteria are met.
    - NCA-5350(4) requires the Design Report be certified by a Registered Professional Engineer (RPE) competent in the applicable field. The RPE confirms all loads and load combinations specified in the Design Specification have been addressed and satisfied.
    - NCA-8310(a) permits application of the ASME 'N' Certification Mark to the Reactor Pressure Vessel which provides certification by an Authorized Nuclear Inspector that all ASME examinations and testing have been completed.
- Therefore, the resolution of DWO will be achieved through ITAAC 02.01.01 activities related to the RPV and the steam generator

# Preliminary Scoping Study

---

- Steam Generator Tubes
  - The applicable primary side conditions were applied to the exterior of the SG tubes and DWO full flow reversal was considered on the interior (secondary side) for the total length of the tube.
  - The resultant alternating stress due to this oscillation is below the ASME Code endurance limit; therefore, preliminary analyses demonstrate that DWO full flow reversal will not result in any fatigue damage to the steam generator tubes.
- Feedwater Plenum Tube-to-Tubesheet Weld
  - Preliminary analyses using bounding DWO transient definitions, assuming complete tube dry out, and conservative tube to plenum interaction, resulted in alternating stresses above the ASME Code endurance limit.
    - The DWO transient definition in this vicinity is undergoing further evaluation.
    - The preliminary DWO alternating stress in relation to the ASME endurance limit, coupled with the analytical conservatisms applied in this evaluation, enable NuScale to confidently predict the final alternating stress due to DWO in this region will be below the ASME Code endurance limit.
    - ITAAC 02.01.01 requires the inspection of the Design Report in which this evaluation will be documented.

# Planned Closure Activities Through ITAAC

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- ITAAC 2.01.01 inspection is performed of the NuScale Power Module “ASME Code Class 1, 2, 3, and CS as-built component Design Reports to verify that the requirements of ASME Code Section III are met”
  - NRELAP5 will provide thermal-hydraulic time histories of design transients in support of the fatigue analysis, including fluid temperatures, pressures, nominal flow rates, and quality
  - TF-1 and TF-2 test data will provide a basis for parameters used to calculate film coefficients and resulting stresses during DWO
  - Thermal response of the tube is much faster than the DWO frequency, so a quasi-static analysis can be performed
  - The stresses from all loadings and transients (including those from DWO) will be combined and compared to allowable stress limits
  - The goal of the SG ASME Code calculations is to confirm that the alternating stresses on the SG tubes, the tube-to-tubesheet welds, and the tubesheets due to DWO stresses are below the ASME endurance limit; thereby enabling these components to withstand infinite cycles

# NuScale Conclusion

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- The successful completion of ITAAC by the licensee constitutes the basis for the NRC determination to allow operation of a facility certified under 10 CFR 52

# Acronyms

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ASME	American Society of Mechanical Engineers	PWR	Pressurized Water Reactor
B&PV	Boiler and Pressure Vessel	RCS	Reactor Coolant System
BWR	Boiling Water Reactor	RPV	Reactor Pressure Vessel
CFR	Code of Federal Regulations	SG	Steam Generator
DCA	Design Certification Application	TH Code	Thermal Hydraulic Code
DHRS	Decay Heat Removal System		
DWO	Density Wave Oscillation		
EPRI	Electric Power Research Institute		
FSAR	Final Safety Analysis Report		
FW	Feedwater		
IFR	Inlet Flow Restrictor		
ISI	Inservice Inspection		
ITAAC	Inspection, Test, Analysis and Acceptance Criteria		
NEI	Nuclear Energy Institute		
NPM	NuScale Power Module		
NSSS	Nuclear Steam Supply System		

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United States Nuclear Regulatory Commission

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# **Steam Generator Design and Related Topics: Steam Generator**

## **NuScale Design Certification Application**

ACRS Subcommittee Meeting  
February 4, 2020

(Open Session)

# Agenda

- NRC Staff Review Team
- Summary of the NRC Staff's Review
- Steam generator materials, design, inspection (Chapter 5)
- Steam generator component design (Chapter 3)
- Initial Test Program (ITP) and Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC); (Chapter 14)
- Accident analysis (Chapter 15)
- Secondary-side flow stability (Chapter 5)

# NRC Staff Review Team

- Technical Reviewers:
  - Gregory Makar
  - Yuken Wong
  - Peter Yarsky
  - Raymond Skarda
  - Carl Thurston
  - Leslie Terry
  - Kaihwa Hsu
- Project Management:
  - Marieliz Johnson
  - Bruce Bavol

## **FSER Section 5.4.1 and 5.4.2 Steam Generator Review**

- Selection, processing, testing, and inspection of materials
- Design for limiting susceptibility to progressive degradation
- Fabrication and processing of ferritic carbon and low-alloy steels
- Fabrication and processing of austenitic stainless steel (pressure boundary)
- Compatibility with the coolant (primary and secondary) and cleanliness control
- Access to shell side
- Ability to implement a steam generator program for progressive forms of degradation (primary and secondary)
- Reasonable assurance that tube integrity (structural and leakage) will be maintained

# Staff's Evaluation:

## NuScale Steam Generators

Key Differences Compared to Operating Reactors

- Primary pressure outside the tube
- Helical coil shape
- First of a kind tube support structure (design and inspection requirements)
- First of a kind feedwater plenum and steam plenum designs
- Inlet flow restrictors with mounting plate (secondary side)

# Staff's Evaluation:

## Effect of these differences on staff review

- Degradation assessment different than operating fleet
- Structural integrity evaluation based on tube collapse rather than burst
- Possible new effects of secondary coolant on degradation
- New flow effects and loose parts potential inside and outside tubes
- Tube support and flow restrictor dynamic effects
- Inspection methods require development (tube shape, internal deposits)
- Inspection analyses require qualification
- Inspection interval

# Staff's Evaluation:

## Status of the Steam Generator review

Chapter 5 confirmatory items will clarify:

- ASME Code classification of the SG supports and SG tube supports
- Description of the steam and feed plenum design

## Staff's Evaluation:

### Steam Generator Program description (FSER 5.4.2)

- Manages progressive forms of degradation
- Mature program for operating reactors
  - Steam Generator Program Guidelines (NEI 97-06)
  - Electric Power Research Industry (EPRI) guidelines
  - Technical Specifications
- Technical Specifications related to tube integrity and inspection
  - Define and require structural and leakage integrity
  - Require inspection, condition monitoring, operational assessment
  - Include full length of the tube using capable techniques
  - Limit primary-to-secondary leakage
  - Limit the allowable through-wall degradation
  - Serve as the ASME Code inservice inspection for SG tubes
  - Require secondary water chemistry program
  - Require inspection reports

# Staff's Evaluation:

## Steam Generator Program inspections

- Tubes inspected from the inside with eddy current testing (ET)
  - Internal and external volumetric degradation (corrosion, wear)
  - Internal and external cracking
- Cracking – plug tube when detected (some plants have exceptions through license amendment)
- Wear from support structures and foreign objects managed based on the cause, ET characterization, and projected growth
- Visual examination on the shell side (tubes, supports, deposits)
- NuScale program described in FSAR Section 5.4.1.6

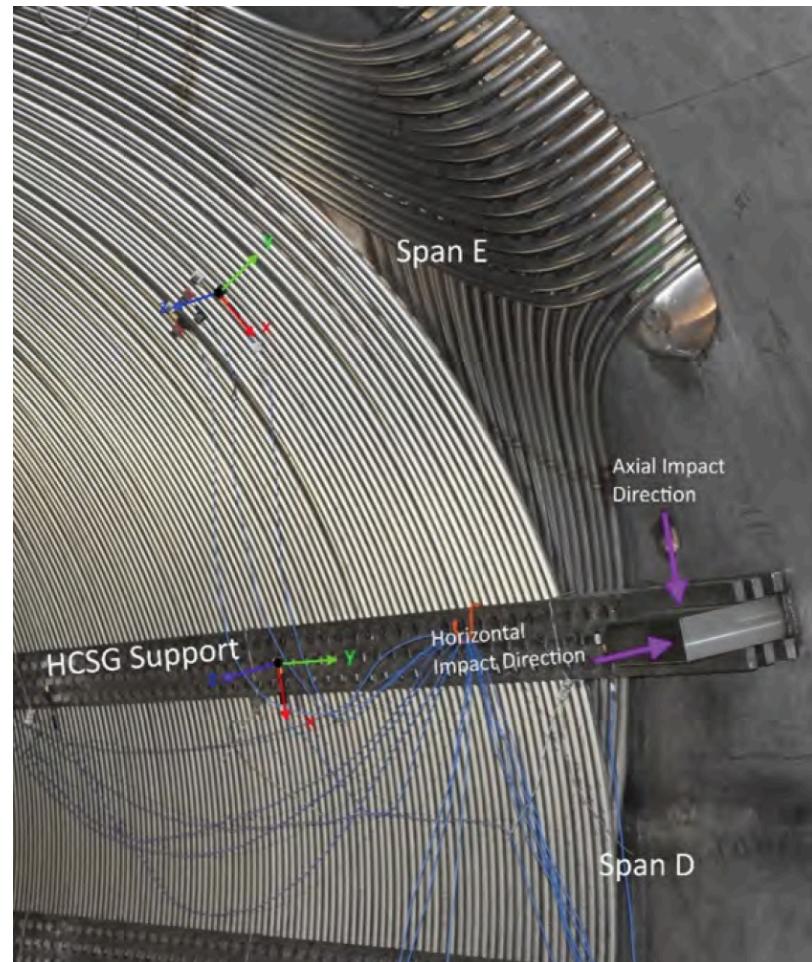


# Staff's Evaluation: Chapter 3

**Chapter 3 topics:**  
**Flow-Induced Vibration**  
**ASME Section III Stress Analysis**

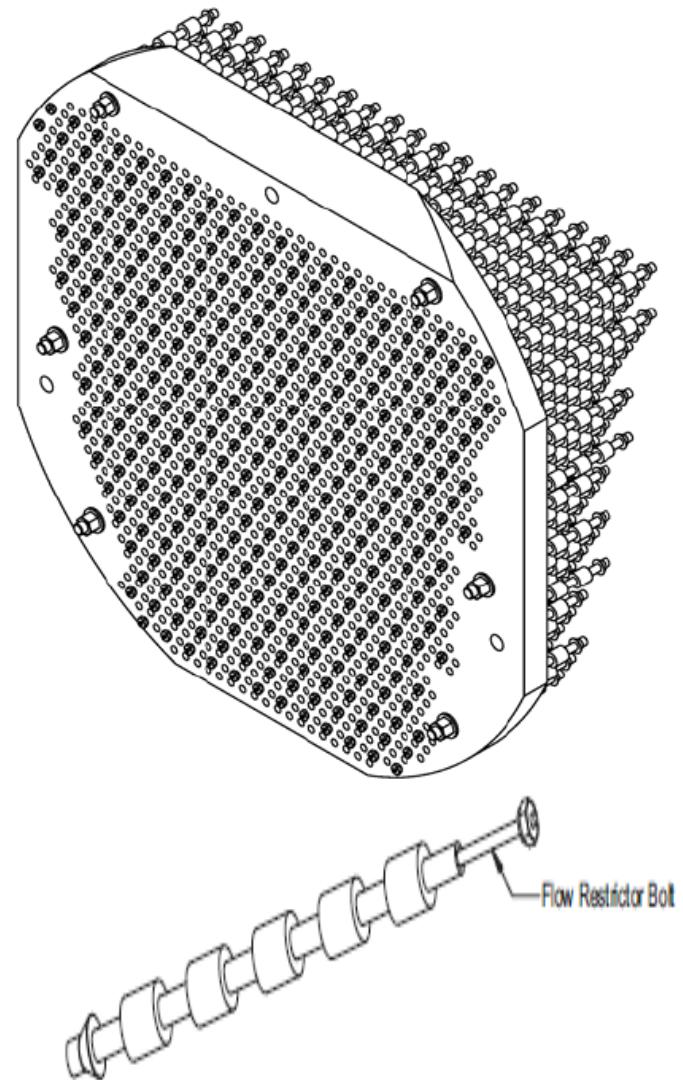
# Staff's Evaluation: HCSG FIV

- Mechanisms evaluated:
  - Flow induced vibration, fatigue life, wear
    - Vortex shedding (VS)
    - Fluid-elastic instability (FEI)
    - Turbulent buffeting (very low due to slow flow)
- Analysis methods are reasonable; margins are acceptable
- Design to be validated with testing in SIET TF-3 facility
  - DCA Part 2 Tier 1, Section 2.1.1 “Design Description”
  - Part 2, Tier 2, Table 14.2-72, “Steam Generator Flow-Induced Vibration Test #72”
  - Acceptance criteria are reasonable



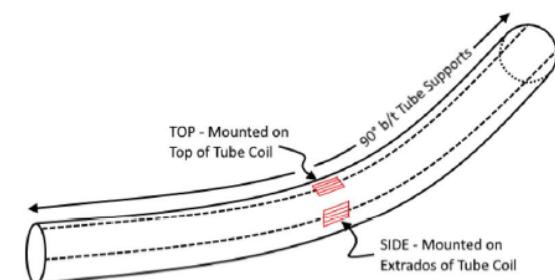
# Staff's Evaluation: SG Inlet Flow Restrictor

- Mechanisms evaluated:
  - Leakage flow instability (LFI)
- Design concepts evaluated by tests
  - Significant margin against LFI
- Final design to be validated with testing prior to initial startup
  - Test plan and acceptance criteria described in comprehensive vibration assessment program (CVAP) Measurement and Inspection Plan Technical Report
    - Plan and criteria are acceptable



# Staff's Evaluation: DWO FIV

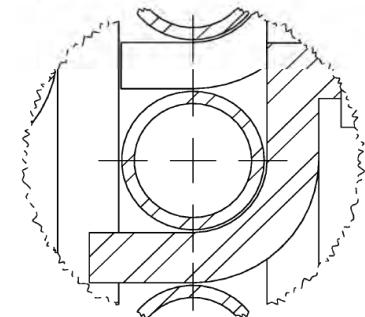
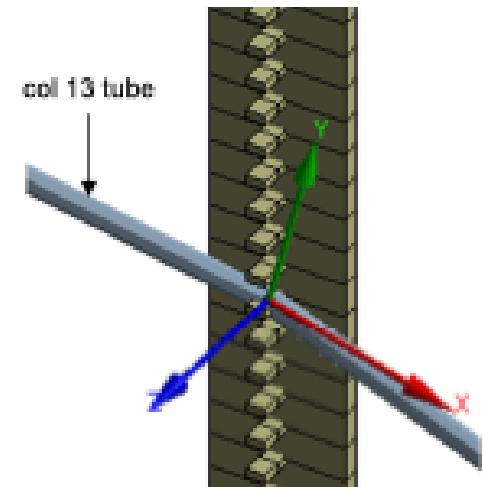
- Density wave oscillation (DWO) observed in TF-2 testing
  - Temperature and flow oscillations in secondary coolant
- TF-2 tubes instrumented with strain gages
- Very long oscillation period
  - Frequency very low
    - DWO will not excite HCSG structural resonances
- Surface strain fluctuations on the order of hundreds of microstrain
  - Alternating stress intensities appear to be below fatigue endurance limit (ASME calculations performed under ITAAC will provide final confirmation)
  - Max surface stresses are below yield and ultimate strengths



Alloy 690 (Ni-Cr-Ir)

# Staff's Evaluation: DWO Wear

- Sliding and wear
  - Oscillating thermal loading could cause tubing to expand and contract, leading to sliding along the tube support tabs
  - Long term wear will be monitored by steam generator program inspections



## Staff's Evaluation: DWO ASME III

- SG tubes are ASME Class 1
- ASME Section III Code requires analysis to address fatigue and design basis loads
- ITAAC 2.1-4.2 exists to confirm that ASME Class 1 components in DCA Tier 1, Table 2.1-2 are designed to ASME Section III requirements
  - Table 2.1-2 includes “RCS integral RPV/SG/Pressurizer”

# Staff's Evaluation: DWO Initial Startup

- One tube in prototype HCSG will be instrumented with strain gages at top, middle, and bottom
  - If DWO occurs, will be measurable in strain gages
  - However, measurements not intended for DWO, since SG tube ASME Section III analyses will include effects of DWO

# Staff's Evaluation: Summary

- DCA commitment ensures TF-3 testing will be performed and acceptance criteria are met
  - DCA Part 2 Tier 1, Section 2.1.1 “Design Description”
  - Part 2, Tier 2, Table 14.2-72, “Steam Generator Flow-Induced Vibration Test #72”
- Density Wave Oscillation (DWO) does not induce significant HCSG vibration
- The effects of any thermally induced stresses will be addressed in ASME Section III analyses via ITAAC
- SG inlet flow restrictor (IFR) testing will confirm the IFR final design will not have adverse vibration effects due to leakage flow instability

# Staff's Evaluation:

## Additional Steam Generator topics

- Chapter 15 – Accident Analysis  
Steam generator design affects some accident analyses
- Stability Topical Report (TR-0516-49417-P)
  - Evaluation of power module stability
  - Assumed secondary-side flow instability
- Secondary-side density wave oscillation (DWO)

## Staff's Evaluation:

### Secondary-Side Density wave oscillation (DWO)

- May generate cyclic loads (must be considered for ASME Code stress calculations)
- ITAAC 2.1-4.2 exists to confirm that ASME Class 1 components are designed to ASME Section III requirements
- Applicant is developing a methodology to analyze secondary-side DWO and assess the methodology for this use

# Abbreviations

- ACRS - Advisory Committee on Reactor Safeguards
- ASME - American Society of Mechanical Engineers
- CVAP - Comprehensive Vibration Analysis Plan
- DWO - Density Wave Oscillation
- EPRI - Electric Power Research Industry
- ET - eddy current testing
- FEI - Fluid-Elastic Instability
- FSAR - Final Safety Analysis Report
- HCSG - Helical Coil Steam Generator
- IFR - inlet flow restrictor
- ITAAC - Inspection, Test, analysis, and acceptance criteria
- ITP - Initial Test Program
- LFI - Leakage Flow Instability
- RCS - Reactor Coolant System
- RPV - Reactor Pressure Vessel
- SF - Single Failure
- SG - Steam generator
- SGIFR - Steam Generator Inlet Flow Restrictor
- VS - Vortex Shedding
- TB - Turbulent Buffeting

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# Questions?



# **BACK-UP SLIDES**

# Staff's Evaluation: Chapter 3

**Chapter 3 topics:**  
**Flow-Induced Vibration**  
**ASME Section III Stress Analysis**

**See Closed Session**



# **NRELAP5 SG Modeling and it's Application to Chapter 15 events**

**Carl Thurston  
NRR/DSS/SNRB**

**See Closed Session**



# **Secondary Side Density Wave Oscillations**

**Ray Skarda, Ph.D.- Reactor Systems**

**Engineer, RES**

**Peter Yarsky, Ph.D.- Senior Reactor**

**Systems Engineer, RES**

**See Closed Session**



LO-0120-68550

January 28, 2020

Docket No. 52-048

U.S. Nuclear Regulatory Commission  
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**SUBJECT:** NuScale Power, LLC Submittal of Presentation Materials Entitled "ACRS  
Subcommittee Presentation: NuScale FSAR Chapter 3 – Protection Against Turbine  
Missiles," PM-0220-68162, Revision 0

The purpose of this submittal is to provide presentation materials to the NRC for use during the upcoming Advisory Committee on Reactor Safeguards (ACRS) Subcommittee Meeting on February 4, 2020. The materials support NuScale's presentation of protection against turbine missiles.

The enclosure to this letter is the nonproprietary version of the presentation entitled "ACRS Subcommittee Presentation: NuScale FSAR Chapter 3 – Protection Against Turbine Missiles," PM-0220-68162, Revision 0.

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

If you have any questions, please contact Marty Bryan at 541-452-7172 or at [mbryan@nuscalepower.com](mailto:mbryan@nuscalepower.com).

Sincerely,

Zackary W. Rad  
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**Enclosure:** "ACRS Subcommittee Presentation: NuScale FSAR Chapter 3 – Protection Against Turbine Missiles," PM-0220-68162, Revision 0

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LO-0120-68550

**Enclosure:**

"ACRS Subcommittee Presentation: NuScale FSAR Chapter 3 – Protection Against Turbine Missiles,"  
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# ACRS Subcommittee

## Presentation

NuScale FSAR

Chapter 3

Protection Against Turbine  
Missiles

February 4, 2020

# Presenters

---

**Josh Parker, P.E.**  
Civil/Structural Analysis Supervisor

**Marty Bryan**  
Licensing Project Manager

# Turbine Missiles – Overview of Topics

- Turbine Missile Definition – Parameters
- Analysis Approach and Methodology
  - Local analyses
  - Global analysis
- Illustrations of Turbine Missile Trajectory and Barriers
  - Reactor Building
  - Control Building
- Conservatisms in Approach
- Summary

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*Protecting People and the Environment*

# Turbine Missile

## NuScale Design Certification Application

ACRS Subcommittee Meeting  
February 4, 2020

# NRC Staff Review Team

- **Technical Reviewers:**  
Sujit Samaddar, NRR/DEX/ESEA  
John Honcharik, NRR/DNRL/NPHP
- **Project Management:**  
Marieliz Johnson, NRR/DRNL/NRLB



# NuScale

# Turbine Missile Spectrum

Assessment of the Turbine Missiles for which protection is required for Compliance with GDC 4

# Determining Turbine Missile Parameters

- NuScale proposes the bounding missile to be 24 inch radius half circle of the rotor weighing 3568 pounds, based on using half of the last stage rotor with blades attached.
- NuScale proposes the bounding missile speed of 476 mph, based on 190% destructive overspeed (6840 rpm).
- COL Item 3.5-1- A COL applicant will demonstrate site specific turbine missile parameters are bounded by the design certification analysis, or provide site-specific turbine parameters.
- Staff concludes the bounding missile described above is acceptable based on past events as documented in EPRI reports and NUREG-1275.

# Regulatory Basis and Use of Barriers

- 10 CFR Part 50, Appendix A, GDC 4, requires SSCs important to safety to be appropriately protected against environmental and dynamic effects, including the effects of missiles that may result from equipment failure.
- Safety-related and risk-significant SSCs for the NuScale design are located within the RXB and CRB.
- Turbine generator rotor shafts are unfavorably oriented such that the RXB and CRB are within the turbine low-trajectory hazard zone.
- To meet the requirements of 10 CFR Part 50, Appendix A, GDC 4, NuScale proposes to use installed or existing structures for protecting safety related SSCs.



# NuScale Turbine Missile Barriers

Assessment of barriers providing required protection in  
compliance with GDC 4

## **Acceptance Criteria for an effective barrier:**

RG 1.115 and SRPs 3.5.1.3 and 3.5.3 recommend sufficient thickness of concrete barrier(s) to prevent perforation and scabbing in the event of turbine missile impact.

# Turbine Missile Barriers:

- 5 ft thick reinforced concrete exterior wall of the RXB as the primary barrier.
- 3 ft reinforced concrete exterior wall and the 3 ft reinforced concrete slab at grade, collectively, as the barriers for the CRB.

# Analysis Methodology:

- TeraGrande non-linear finite element code with ANACAP reinforced concrete model.
- Estimate the depth of penetration.
- Use modified National Defense Research Council equation to establish minimum barrier thickness to meet acceptance criteria.

# Confirming simulation capability of computer code:

- TeraGrande code with ANACAP reinforced concrete is well established and used for AIA.
- Ability to simulate full scale high energy rotor impact test conducted at SNL by EPRI.
- Close correlation between simulation and test results.

# Barrier Model:

- Walls and slab represented by plate elements.
- The model boundaries fixed.
- Modeled area is smaller than actual wall dimension.
- Impact on center of the model.
- Strain contours plotted.

## Results:

- Change in stress levels radiating from impact zone rapidly tend to be zero (localized effect).
- Global effect of impact can be ignored.
- RXB wall near perforation.
- Assumed all equipment lost in service gallery from secondary missiles (scabbing), redundant equipment is provide in a separate location to keep the plant safe
- CRB wall perforated – exit-velocity relatively low – minimum thickness requirement met based on computed floor-slab penetration.

# Staff Conclusion:

There is reasonable assurance that SSC's important to safety will be protected as required by GDC 4, from the characterized missile, by the protective barriers considered in the NuScale design.

# Abbreviations

AIA - aircraft impact assessment

CRB - Control Building

EPRI - Electric Power Research Industry

RXB - Reactor Building

SSC - structures, systems, and components

SNL – Sandia National Laboratories

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# Questions?

Non-Proprietary



# **BACK-UP SLIDES**



## Protection Options:

- Reducing the potential for missile generation.
- Selecting favorable turbine orientation.
- Using barrier(s) for missile protection.



LO-0120-68654

January 31, 2020

Docket No. 52-048

U.S. Nuclear Regulatory Commission  
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**SUBJECT:** NuScale Power, LLC Submittal of Presentation Materials Entitled "ACRS  
Subcommittee Presentation: NuScale FSAR – Emergency Core Cooling System  
Valve and Inadvertent Actuation Block Design," PM-0120-68441, Revision 0

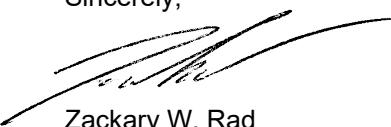
The purpose of this submittal is to provide presentation materials to the NRC for use during the upcoming Advisory Committee on Reactor Safeguards (ACRS) Subcommittee Meeting on February 4, 2020. The materials support NuScale's presentation of the emergency core cooling system valve and inadvertent actuation block design.

The enclosure to this letter is the nonproprietary presentation entitled "ACRS Subcommittee Presentation: NuScale FSAR – Emergency Core Cooling System Valve and Inadvertent Actuation Block Design," PM-0120-68441, Revision 0.

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

If you have any questions, please contact Rebecca Norris at 541-602-1260 or at [RNorris@nuscalepower.com](mailto:RNorris@nuscalepower.com).

Sincerely,



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Enclosure: "ACRS Subcommittee Presentation: NuScale FSAR – Emergency Core Cooling System Valve and Inadvertent Actuation Block Design," PM-0120-68441, Revision 0

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LO-0120-68654

**Enclosure:**

"ACRS Subcommittee Presentation: NuScale FSAR – Emergency Core Cooling System Valve and Inadvertent Actuation Block Design," PM-0120-68441, Revision 0

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# ACRS Subcommittee Presentation

**NuScale FSAR**

**Emergency Core Cooling System  
Valve and Inadvertent Actuation  
Block Design**

**February 4, 2020**

# Presenters

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**Paul Infanger**  
Licensing

**Daniel Lassiter**  
Engineering

# ECCS Valve Operation

---

- Emergency core cooling system (ECCS) valves receive actuation demand on an ECCS actuation signal or loss of DC power to ECCS trip valves
- Inadvertent actuation block (IAB) feature prevents ECCS valve opening if the differential pressure between the reactor coolant system (RCS) and containment (CNV) is above the IAB threshold pressure
  - This feature prevents opening due to spurious signals or equipment failures at normal operating pressures but permits opening in loss-of-coolant accident (LOCA) conditions
  - Previous IAB range 1000-1200 psi
    - Upper limit supports critical heat flux (CHF) criteria for postulated inadvertent opening or loss of power events
    - Lower limit protects coolant levels for small breaks

# ECCS Valve Testing

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- Initial ECCS valve testing was done in 2015 for “Proof of Concept”
- Testing was done with air and ambient temperature water
  - Testing verified ECCS valve functionality with remote pilot actuators
  - Testing verified IAB blocking and release functions

# ECCS Valve Audit

---

- Identified need to demonstrate ECCS valve functions at operating conditions
  - DCA Demonstration Test Program performed ECCS valve and IAB function tests at operating pressures and temperatures
  - Two-phase effects in the ECCS valve control chamber and trip line affected operation of the IAB
    - Slower response affected the ability of the IAB to reliably block at threshold (approximately 1200 psid) and release 1000–1200 psid
    - Adjustments were made to the IAB spring force and internal orifices
    - Sensitivity testing determined that 300 psi to 400 psi range (versus 200 psi) was needed for reliable blocking and release
    - IAB test was repeated and demonstrated to reliably block above 1300 psid and release between 900 psid and 1000 psid

# Previous FSAR Analysis

---

- DCA Revision 3 Chapter 6 and 15 analyses prior to IAB changes (August 2019) had the following conditions
  - Assumed all ECCS valves remain closed due to IAB block function above 1200 psid
  - Evaluated ECCS valves opening between 1200 psid and 1000 psid
  - All ECCS valves (RRVs and RVVs) open at the same time

# Revised FSAR Analyses

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- Impacted FSAR Sections
    - FSAR 6.2 Peak CNV Pressure
    - FSAR 15.6.5 Loss of Coolant Accidents
    - FSAR 15.6.6 Inadvertent Operation of ECCS
  - Revised assumptions
    - Assumes all ECCS valves remain closed due to IAB block function above 1300 psid
    - Evaluated ECCS valves opening between 900 and 1000 psid
  - Revised analysis results submitted in September 2019 and reviewed in NRC October audit in Corvallis
  - DCA Revision 4, including revised FSAR analysis results, formally submitted January 2020
-

# Revised FSAR Analyses

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- Impact of revised IAB threshold and release pressures
  - FSAR 6.2 limiting CNV peak pressure (inadvertent RRV opening)
    - » Second RRV opens at 1000 psid (before RVVs – open at 900 psid)
      - » Slightly higher CNV pressure due to larger mass release before RCS and CNV pressures equalize
  - FSAR 15.6.5 LOCA - limiting water level above fuel
    - » Staggered IAB opening pressures not limiting
    - » IABs release at 900 psid – lower minimum water level above fuel
  - FSAR 15.6.6 – inadvertent ECCS valve (RVV) opening
    - » Not sensitive to different ECCS valve opening pressures – MCHFR occurs before 0.5 seconds
    - » No change in MCHFR due to IAB threshold change – other model changes, including more conservative reactivity feedback and flow resistance, impacted MCHFR
    - » Verified 1300 psid threshold adequate to maintain remaining ECCS valves closed until reactor trip

# Updated Analysis Results

Event / Acceptance Criteria	DCA Rev 3 Results	Updated DCA Rev 4 Results	Comments
Peak CNV Pressure (RRV Opening) CNV Design Pressure - 1050 psia	986 psia	994 psia	Change in peak pressure due to staggered IAB release (2 <sup>nd</sup> RRV at 1000 psid, RVVs at 900 psid)
LOCA - Minimum Water Level Above Top of Active Fuel	1.7 ft	1.5 ft	Change due to lower IAB minimum release pressure 900 psid
Inadvertent ECCS valve opening – MCHFR limit 1.13	1.41	1.32	Change due to model revisions not IAB threshold change

# Operational IAB Testing

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- Operational testing established to assure safety functions are met
  - Technical Specification 3.5.1 requires surveillances in accordance with the inservice testing (IST) program
  - FSAR 3.9.6.4 defines IST Alternate Authorization
    - Preservice testing for all RVV and RRV IABs on all NPMs
      - » Verify IAB minimum analyzed closing threshold pressure and opening release pressure is within analyzed range
    - Operational testing
      - » First refueling of first NPM – all IABs tested (same as preservice test)
      - » Second NPM refueling – one RRV IAB and one RVV IAB tested
      - » Subsequent outages – IAB test frequency determined by ASME OM Mandatory Appendix IV
  - FSAR 3.9.6.1 Functional design and qualification per ASME QME-1

# Conclusions

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- CNV peak pressure results slightly more limiting (8 psi) due to explicit evaluation of ECCS valves opening at different IAB release pressures
- LOCA minimum water level above fuel results slightly more limiting (~0.2 feet difference) due to lower minimum IAB release pressure of 900 psid
- Inadvertent ECCS valve opening MCHFR slightly more limiting due to evaluation of error corrections and more bounding model input, not from IAB change
- All updated event results demonstrated margin to acceptance criteria
- Preservice and operational testing programs established to assure safety functions maintained

# Acronyms

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ASME	American Society of Mechanical Engineers
CHF	critical heat flux
CNV	containment vessel
DC	direct current
DCA	Design Certification Application
ECCS	emergency core cooling system
FSAR	Final Safety Analysis Report
IAB	inadvertent actuation block
IST	inservice testing
LOCA	loss-of-coolant accident
MCHFR	minimum critical heat flux ratio
NPM	NuScale Power Module
OM	Operations and Maintenance of Nuclear Power Plants
psi	pounds per square inch
psid	pounds per square inch differential
QME-1	Qualification of Active Mechanical Equipment Used in Nuclear Facilities
RCS	reactor coolant system
RRV	reactor recirculation valve
RVV	reactor vent valve

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*Protecting People and the Environment*

## **Inadvertent Actuation Block (IAB) Valve**

### **NuScale Design Certification Application**

ACRS Subcommittee Meeting  
February 4, 2020



# NRC Staff Review Team

- Technical Reviewers:
  - Thomas G. Scarbrough
- Project Management:
  - Marieliz Johnson

# NuScale ECCS Valve System

- NuScale reactor uses a first-of-a-kind (FOAK) valve system design for the Emergency Core Cooling System (ECCS).
- ECCS design includes 3 five-inch Reactor Vent Valves (RVVs) and 2 two-inch Reactor Recirculation Valves (RRVs) that open to allow natural circulation for emergency core cooling.
- Each RVV and RRV consists of a main valve, inadvertent actuation block (IAB) valve, solenoid trip valve, and solenoid reset valve connected by small hydraulic tubing.
- During 2019, NuScale conducted ECCS Valve Design Demonstration Testing to satisfy 10 CFR 52.47(c)(2) and 50.43(e) for this FOAK design feature.

# NRC Regulatory Requirements for New Design Features

- 10 CFR 52.47(c)(2) requires, in part, that a DCA for a reactor design that uses passive means to accomplish its safety functions must provide an essentially complete design and must meet 10 CFR 50.43(e).
- 10 CFR 50.43(e) requires, in part, that a DCA for a reactor design that uses passive means to accomplish its safety functions will be approved only if the performance of each design safety feature has been demonstrated through either analysis, test programs, experience, or a combination thereof, with a requirement that sufficient data exist on design safety features to assess analytical tools for safety analyses over a sufficient range of normal operating and transient conditions, and accident sequences.

# NRC Staff's Evaluation of NuScale ECCS Valve System

- NRC staff reviewed the ECCS valve design description in the NuScale DCA, including meetings with NuScale personnel and audits of design documentation.
- NRC staff conducted on-site audits at Target Rock of ECCS Valve Design Demonstration Testing to review test plans, procedures, results, and corrective action, including walkdowns of test setup and observations of testing activities.
- NRC staff conducted vendor inspections of NuScale QA oversight of Target Rock activities.
- NRC audit report (ML19340A019) dated 12-19-2019 describes NRC review of ECCS Valve Design Demonstration Testing to satisfy 10 CFR 52.47(c)(2) and 50.43(e) with follow-up items.

# NuScale ECCS Valve Design Demonstration Testing Summary

- NuScale conducted ECCS Valve Design Demonstration Testing with two-inch globe valve RRV mock-up in 2019 at Target Rock facility.
- Test objectives were to demonstrate:
  - Main valve functionality at operating temperature and pressure fluid conditions
  - IAB valve functionality at operating temperature and pressure fluid conditions
  - IAB valve and trip line functionality at operating chemistry fluid conditions, including boric acid solution
- Test conditions included saturated steam, subcooled water, and nominal temperature water with pressures ranging from 30 to 1850 psig.

# NuScale ECCS Valve Design Demonstration Testing Results

- In August 2019, NuScale reported that the ECCS Valve Design Demonstration Testing had been completed.
- Testing revealed that certain aspects of the original ECCS valve system design did not perform as expected.
- Several design changes to the ECCS valves were necessary based on test results including:
  - Reduction in main valve control chamber orifice diameter
  - Reduction in IAB valve port inlet diameter
  - Reduction in IAB valve shim size
- Operating range for IAB valve will be expanded from 1100 psid +/- 100 psid to +/- 200 psid.
- Two-inch RRV test results extrapolated to help demonstrate five-inch RVV performance.

# NuScale ECCS Valve Final Test Report (FTR)

- NuScale FTR concludes ECCS Valve Design Demonstration Testing was successful with the following key observations:
  - Ratio of inflow and outflow for main valve is critical to allow proper depressurization of main valve control chamber.
  - IAB valve threshold and release pressure is significantly impacted by fluid temperature.
  - Location and size of minimum outflow area downstream of main valve control chamber is critical to IAB valve threshold pressure.
  - Dynamic performance limitations of IAB valve do not allow threshold and release pressures to be within a narrow range such that IAB valve pressure range was increased to 900-1300 psid to allow for satisfactory IAB valve performance under test fluid conditions.

# NRC Audit Report Conclusions

- NuScale ECCS Valve Design Demonstration Testing revealed need to modify valve design and performance assumptions.
- Lessons learned need to be addressed in ASME QME-1 Standard qualification and inservice testing (IST) programs.
- ECCS performance attributes in DCA not consistent with results of ECCS Valve Design Demonstration Testing.
- NuScale will update DCA and applicable design documents to reflect design modifications and performance characteristics.
- COL holder will address lessons learned from ECCS Valve Design Demonstration Testing for RVV and RRV qualification.
- Upon follow-up item resolution, NRC staff will conclude its review of NuScale ECCS Valve Design Demonstration Testing to satisfy 10 CFR 52.47(c)(2) and 50.43(e).

# NRC Audit Follow-Up Items

- Item 1: NuScale will update IST program description for ECCS valves in DCA, including a request to depart from ASME OM Code requirements for IAB valve testing.
- Item 2: NuScale will update DCA provisions for ECCS valve performance (including IAB valve) to reflect lessons learned from ECCS Valve Design Demonstration Testing.
- Item 3: NuScale will update applicable ECCS valve design documents to reflect design modifications.

# Current Status

- On 10-24-2019, NuScale submitted a letter with the status of its actions to address ECCS valve audit follow-up items (ML19297H199).
- On 11-13-2019, NuScale submitted a letter with its draft update to IST program description, including alternative request, for DCA Revision 4 (ML19317E531).
- Upon notification of completion, NRC staff will verify that audit follow-up items have been resolved.
- During next SER phase, NRC staff will finalize its review of the ECCS Valve Design Demonstration Testing Program to satisfy 10 CFR 52.47(c)(2) and 50.43(e) in demonstrating safety features of NuScale ECCS valve system to support NuScale DCA.

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# Questions?

Non-Proprietary



LO-0120-68656

January 31, 2020

Docket No. 52-048

U.S. Nuclear Regulatory Commission  
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**SUBJECT:** NuScale Power, LLC Submittal of Presentation Materials Entitled "ACRS Subcommittee Presentation: NuScale FSAR Chapter 8 – Electric Power," PM-0220-68597, Revision 0

The purpose of this submittal is to provide presentation materials to the NRC for use during the upcoming Advisory Committee on Reactor Safeguards (ACRS) Subcommittee Meeting on February 4, 2020. The materials support NuScale's presentation of electric power.

The enclosure to this letter is the nonproprietary presentation entitled "ACRS Subcommittee Presentation: NuScale FSAR Chapter 8 – Electric Power," PM-0220-68597, Revision 0.

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

If you have any questions, please contact Marty Bryan at 541-452-7172 or at [mbryan@nuscalepower.com](mailto:mbryan@nuscalepower.com).

Sincerely,



Zackary W. Rad  
Director, Regulatory Affairs  
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**Enclosure:** "ACRS Subcommittee Presentation: NuScale FSAR Chapter 8 – Electric Power," PM-0220-68597, Revision 0

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LO-0120-68656

**Enclosure:**

"ACRS Subcommittee Presentation: NuScale FSAR Chapter 8 – Electric Power," PM-0220-68597,  
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# ACRS Subcommittee Presentation



**NuScale FSAR**

**Chapter 8**

**Electric Power**

**February 4, 2020**

# Presenters

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**J. Ehlers**

Electrical Engineering Supervisor

**M. Bryan**

Licensing Project Manager

# NuScale Electric Power

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*Safety of the NuScale Plant Design is  
Not Dependent on Electric Power*

- Based on the design that is consistent and compliant with NRC-approved Topical Report.
  - “Safety Classification of Passive Nuclear Power Plant Electrical Systems,” TR-0815-16497-P-A, January 2018.
  - Includes Conditions of Applicability specified to justify classification of plant electrical systems as non-Class 1E.
  - Chapter 1 of Safety Evaluation Report (SER) documents NRC staff review and conclusion that design is consistent with Topical Report and appropriately considers electric power non-Class 1E as described in the Design Certification Application (DCA), Part 2, Tier 2.

# NuScale Electric Power

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- Design Conformance with Topical Report Documented in Part 2, Tier 2, Chapter 8:
  - Table 8.3-9, “FSAR Cross Reference for the Conditions of Applicability and NRC SER Limitations and Conditions for TR-0815-16497-P-A,” and
  - Table 8.3-10, “FSAR Cross Reference for the EDSS Augmented Provisions in TR-0815-16497-P-A”
- These FSAR tables map the Topical Report conditions to FSAR locations that demonstrate conformance.
  - Design features
  - Design requirements

*Tables includes specific FSAR locations that demonstrate alignment with the five SER conditions*

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# Acronym

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EDSS      Highly reliable DC power system

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NRC Staff Presentation on

# **Applicability of Topical Report, “Safety Classification of Passive Nuclear Power Plant Electrical Systems”**

NuScale DCA Review, Phase 5  
February 4, 2020

# Purpose

- To brief the ACRS SC members on how NuScale DCA incorporated the Conditions and Limitations of staff's safety evaluation report for Topical Report, TR-0815-16497, "Safety Classification of Passive Nuclear Power Plant Electrical Systems."

## Background/Timeline

- The NRC staff issued its safety evaluation for NuScale TR-0815-16497, “Safety Classification of Passive Nuclear Power Plant Electrical Systems,” (TRSE) in June 2017 (ML17170A201). The staff approved the TR with 6 conditions and limitations.
- The staff briefed the ACRS (FC) in July 2017.
- In its July 26, 2017 letter, the ACRS recommended the TR to be approved only for NuScale design and provided additional comments (ML17205A380).
- The staff responded to the ACRS’s comments in September 2017 (ML17221A058).
- The NRC docketed the “-A” version of the TR in February 2018 (ML18054B607).

# Applicability of TR to NuScale DCA

- NuScale TR-0815-16497 is incorporated-by-reference in the DCA,
- In January 2018, the staff requested NuScale (RAI 9359) to describe how its design meets the 5\* conditions of the TRSE, and asked NuScale to update the DCA accordingly (ML18028A008).
- In March 2018, NuScale responded to the RAI (ML18086B096)
- In the following slides, the staff will describe how NuScale addressed the TR's 5 conditions in the DCA.

*\*The staff's TRSE contained 6 conditions and limitations. Per ACRS recommendation, the staff revised its SE to approve the TR only to be applicable to NuScale design. As such, in the "-A" version of the TR, and the associated staff SE, the number of conditions and limitations was reduced to 5.*

## Highly Reliable dc Power System (EDSS)

- Non-Class 1E dc power system to which augmented design, and quality assurance (QA) provisions are applied.
- two dc subsystems:
  - (1) the EDSS-common (EDSS-C) plant subsystem serves plant common loads that have functions that are not specific to any single NuScale Power Module (NPM) and
  - (2) the EDSS-module-specific (EDSS-MS) plant subsystem consists of up to 12 separate and independent dc electrical power supply systems, one for each NPM.
- Based on its review of the TR-0815-16497 to the DCA, the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems.
  - Staff approved NuScale's Exemption Request from the requirements of GDC 17

## Condition 4.1

- Address the guidance in Regulatory Guide (RG) 1.155, “Station Blackout,” Appendix A, “Quality Assurance Guidance for Non-Safety Systems and Equipment,” in sufficient detail to enable the NRC staff to verify that the relevant QA program would meet or exceed the guidance in RG 1.155.
- Disposition of Condition 4.1:
  - DCA Part 2, Tier 2, Section 8.3.2.2.2, states that an augmented quality assurance (QA) program is applied to the EDSS and the program meets the QA provisions of RG 1.155.
  - The staff finds the disposition acceptable because DCA Part 2 addresses the QA provisions of RG 1.155, Appendix A.
  - Therefore, the NRC staff finds that the applicant met Condition 4.1. FSER Chapter 8 documents the staff’s evaluation supporting this conclusion.

## Condition 4.2

- Confirm that the valve-regulated lead-acid (VRLA) batteries and their structures are seismic Category 1. To provide reasonable assurance that the VRLA batteries will perform as intended, an applicant that references the TR shall provide a COL action item to support that the VRLA batteries and their structures are seismic Category 1. A qualification testing plan includes environmental and seismic qualification and a technical functional requirement for VRLA batteries to show they can perform as intended.

## Condition 4.2 (Cont'd)

- Disposition of Condition 4.2:
  - DCA Part 2, Tier 2 states:
    - the EDSS is classified as seismic Category I
    - EDSS design accommodates the effects of environmental conditions
  - The staff finds the disposition acceptable since the EDSS complies with GDC 2 as the EDSS components are located in seismic Category I structures and the EDSS has augmented design requirements for environmental qualification.
  - Therefore, the NRC staff finds that the applicant met Condition 4.2. FSER Chapter 8 documents the staff's evaluation supporting this conclusion.

## Condition 4.3

“Demonstrate that operator actions are not necessary to ensure the performance of safety related functions for any postulated DBE (i.e., the design does not include Type A variables as defined in IEEE Std. 497 2002, as modified in RG 1.97, Regulatory Position C.4), as presented in Chapter 15 of its FSAR and the human factors analysis in Chapter 18 of its FSAR.”

- Chapter 15 DCA review concluded that no operator actions are necessary to successfully mitigate a DBE out to 72 hours.

## Condition 4.4

“Evaluate the frequency for which a combination of an AOO and an actuation of the NuScale ECCS is realistically expected to occur, and show that such a combination of events is not expected to occur during the lifetime of the module.”

- Means of uncontrolled RCPB coolant loss are:
  - LOCA
  - Inadvertent operation of an ECCS valve
    - Operator error
    - Valve failure
  - AOO coincident with loss of nonsafety-related DC power

## Condition 4.4 (Cont'd)

- LOCA is classified as a postulated accident not expected to occur in the lifetime of the plant (SRP 15.0)
- Inadvertent operation of an ECCS valve
  - Operator error opening the ECCS valves is considered an AOO but the IAB valves prevent RPV coolant discharge
  - Mechanical failure of the safety-related ECCS valve is not expected to occur in the lifetime of the plant.
- AOO coincident with the loss of nonsafety-related DC power
  - Loss of the highly reliable non-safety-related DC power (EDSS) is not realistically expected to occur in the lifetime of the module based on design attributes
  - For a longer term loss of AC power, DC power is retained long enough such that the subsequent opening of the ECCS valves does not challenge containment integrity

## Condition 4.5

“Demonstrate that the reactor can be brought to a safe shutdown using only safety-related equipment in the absence of electrical power following a DBE, with margin for stuck rods. Alternatively, an applicant referencing this TR may provide justification, for NRC review, for a less restrictive condition.”

- Shutdown may not be maintained assuming DBE conditions at or near EOC conditions
- NuScale provided a less restrictive condition demonstrating the SAFDLs are not exceeded on a potential return to power assuming a stuck rod
  - Less restrictive SAFDL condition is consistent with SECY-18-0099
- Applicant's Chapter 15 analysis demonstrated, and the staff agrees, the SAFDLs are met.