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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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NuSCALE SUBCOMMITTEE

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WEDNESDAY

MARCH 4, 2020

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2D10, 11545 Rockville Pike, at 8:30 a.m., Walter L. Kirchner, Chair, presiding.

COMMITTEE MEMBERS:

WALTER L. KIRCHNER, Chair

RONALD G. BALLINGER, Member

DENNIS BLEY, Member

CHARLES H. BROWN, JR., Member

VESNA B. DIMITRIJEVIC, Member

JOSE MARCH-LEUBA, Member

DAVID PETTI, Member

JOY L. REMPE, Member

PETER RICCARDELLA, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANTS:

MICHAEL L. CORRADINI

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

MIKE SNODDERLY

P R O C E E D I N G S

(8:30 a.m.)

CHAIR KIRCHNER: We're back in session. This is day three of our NuScale Subcommittee meeting. This is an open session. And we have a little change to the schedule here to kick things off.

So, Joe, would you just introduce yourself for the record, and then we're going to go over some information related to instrumentation, and then we'll pick up the schedule with NuScale.

So go ahead, Joe.

MR. ASHCRAFT: My name is Joe Ashcraft. I'm in the EICA branch, I&C branch, technical reviewer for NuScale.

So we had some questions as far as the sensors' classification and where it's shown. And so I'm going to kind of go through that briefly. Charlie had some questions, but I think they're more in the proprietary nature, so we might have to go through closed session on some of his questions.

But generally, I'm going to speak first to their sensor report, which is rev two, and that's proprietary. But in that, there's a table 7.1 that shows the level sensors and their classifications and what they are, the ranges, et cetera, and the quantity.

MEMBER MARCH-LEUBA: Sorry, this is not proprietary, the one we have on the table?

CHAIR KIRCHNER: It has no markings, proprietary.

MR. ASHCRAFT: No, what I gave you is just a ---

(Simultaneous speaking.)

MR. ASHCRAFT: Right.

CHAIR KIRCHNER: Okay. Thank you.

MR. ASHCRAFT: And this table actually has no markings in their sensor report, but I decided not to give it to you. But anyway, so that table really lays quantity for the pressurizer level and RPV riser level. It shows that it's one sensor, and there are four of them. And it shows the zero to 100 percent, and the pressurizer level span is 130, which is the top part of the riser level span is 554, which would go down lower.

And then, just kind of let you know what's going on with the sensor technical report, it's laid out in four phases. So phase one, which is what we reviewed in our SE, or looked to, is really where they -- NuScale was looking for technology selection. So they're confident with what they've selected.

Now, they've got phase two, which is proof of concept. And it says in the report that they should have finished at the end of 2019. But I don't know the status of that. But then phase three is where they go into product development. And phase four is the environmental qualification. So, it's similar to all the -- like the ECCS valves, there's a lot of stuff that's going to take place down the road, and we just don't have those answers.

So, now, as far as the DCA, so chapter seven, what we do for instrumentation, we look to see that they're qualified for what they're described. But we point to chapter three because that's where the qualifications of the sensors and all components are done. In Section 7.1.1.1, it describes -- this is where they're kind of going through the design-basis for their sensors, but it's pointing to Section 3.2 for classification.

MEMBER BLEY: I lost the thread, are you -- chapter 7 of the DCA?

MR. ASHCRAFT: DCA, yeah.

MEMBER BLEY: All right, so sensor report. Okay.

MR. ASHCRAFT: Right. So, I'll put the sensor report -- we may come back to it, but like I said, it's proprietary in nature. So questions, we may have to close the session to get to.

So now I'm in the DCA, and I think that goes more to Joy's concern of where it shows what's going on as far as the sensors. Now, this all came about -- they had that I&C design mod where they took out the RPV level as part of the initiation. But that sensor, which is pressurizer level and RPV riser level were classified A1, and it remains classified A1.

And the signal goes to the MPS, and that's where they do the scaling of that. So they take the top part of the analog and say, well, that's pressurizer level in the bottom part. And we don't have that information as far for scaling.

So it goes to the MPS, and then after that, as with all their safety-related instruments, the signals go out through isolation and end up in the safety display board for PAM variables, et cetera.

Now, that's -- it's called safety display, but it's non-safety, and it's primarily because they don't have any PAM-A variables which would have required, you know, safety-related for the PAM-A variables. But they don't have that, so all they have are B, C, D, and E, or whatever.

So that signal goes out of the MPS through isolation to the safety display. And I think that was a question Joy had asked about. And that's done throughout the industry.

DR. CORRADINI: That's what I guess I want to understand. This is not uncommon?

MR. ASHCRAFT: No, no.

DR. CORRADINI: Okay, fine.

MR. ASHCRAFT: I mean, the biggest concern or issue or whatever is these are new-type sensors -- or they're not new technology. But they haven't been used in this -- you know, this type of scenario. So, but --

MEMBER REMPE: Could I?

MR. ASHCRAFT: Sure.

MEMBER REMPE: Are you done, Mike, with your question?

DR. CORRADINI: I just want to make sure that it was clear that this is -- had been done and is commonly done in industry now.

MEMBER REMPE: Okay.

DR. CORRADINI: The nuclear industry now.

MEMBER REMPE: So just to make sure we're all on the same track because there has been some slight information that maybe wasn't quite accurate. The sensors are safety-related sensors in all cases for water level in the containment as well as the pressure riser, which is also the same sensors, just a bit longer for the RPV.

MR. ASHCRAFT: Right. And that's on one of these tables.

MEMBER REMPE: Yeah, but the function is non-safety related for the RPV and the pressurizer, correct?

MR. ASHCRAFT: Right. And that shows up on table of the DCA --

MEMBER REMPE: 7.1-9.

MR. ASHCRAFT: Right. So what that says -- so the signal --

MEMBER REMPE: I get what you're saying. I just am summarizing what you said, okay?

MR. ASHCRAFT: Okay.

MEMBER REMPE: But now, if during this meeting, Charlie said, hey, the rad levels aren't that high in the -- and the applicant didn't tell me to be clear. Earlier this week, I heard you say that --

MEMBER BROWN: Radiation levels aren't high?

MEMBER REMPE: I thought though you said that earlier this week.

MEMBER BROWN: I don't remember --

(Simultaneous speaking.)

MEMBER BROWN: I don't think my brain was that fried.

MEMBER REMPE: I thought I heard you say that.

MEMBER BROWN: I mean, I was awake the whole time.

MEMBER REMPE: Okay, well, anyway, in the topical report about the sensors, it acknowledges that the rad levels are higher than what's typically seen in a conventional light-water reactor. That's you're understanding too?

MR. ASHCRAFT: Yes, but keep in mind -- so, you've got your radar guide tube, which is in the area --

MEMBER REMPE: Right.

MR. ASHCRAFT: -- and they place the sensors because they're mostly -- they're digital and stuff, they've got to be outside to be able to work.

MEMBER REMPE: Absolutely.

But, okay, so let's talk about the radar-based sensor, which has changed over time. Even the whole sensor has changed over time. But you have in chapter three, a cumulative rad level, and you have peak temperatures in there. But you do acknowledge that, hey, thermal expansion might be an issue with the vessel versus the radar-based waveguide.

And what I'm wondering is, are the properties of this radar-based waveguide, the ability to have a signal shot through it and come back, isn't that also a function of the properties of the material, which vary with temperature?

MR. ASHCRAFT: That is correct. But I mean, that's --

MEMBER REMPE: Okay. So is it really temperature, or is it temperature gradient it's exposed to? And is it radiation levels or radiation -- flux gradient in the core?

MR. ASHCRAFT: Well, we had thought to see if NuScale can answer that. So that question, I mean, that tube is in the pressurizer levels going down. So it's going to be exposed to whatever, temperature gradient and --

MEMBER REMPE: Right. And the speed of sound. Okay, but my brain isn't maybe calibrated to what this particular sensor is. But with an ultrasonic thermometer, you've got to worry about the speed of sound in the material, and that varies with temperature. So the calibration of it isn't just going to be dependent on peak temperature and peak --

and cumulative rad levels, it's the actual what it sees. And within a reactor that's going through a transient, that could change with time.

MR. ASHCRAFT: So they've selected their centers that they believe it's going to work for their design, and they're doing -- and maybe they completed their proof of concept at this point. They were supposed to be completed at the end of this last year. But that's where they will just, you know, figure that out.

MEMBER REMPE: Okay, but you are regulating -- if you don't mind, let me finish, okay?

PARTICIPANT: All right.

MEMBER REMPE: Okay, but you have in chapter three, some requirements that they have to meet, and you've listed cumulative rad levels, and you've listed peak temperature. What about temperature gradient and flux gradient? Because it may not -- why aren't those things listed in table three -- chapter three of that table?

MR. ASHCRAFT: Well, those are not typical qualification aspects. I mean, so when they designed -- just like any other transmitter, whatever, when they go to do their setpoint calc, they will account for any of those types of issues.

MEMBER REMPE: Okay, so it's not just what it sees -- okay, those conditions will change. And what I'm trying to get to is, in the sensor development stuff I did in the past, we had not just considered normal operation. We had to consider things that might change during the accident. And so you need to think about the whole situation and all I see your plots of peak temperature and things like that they -- that are included there.

And I just am wondering, how do we document? You need to think about calibrating not just for the worst situation but the time-dependent situation. Because, again, if it's changing along its length, it may be a lot more difficult to have a sensor. And so it needs to be carefully looked at by the staff when they come in.

MR. ASHCRAFT: Well, I will say for anyone that's seen the scaling for steam generator levels of existing plants, it's, you know, you've got steam, you've got boiling -- you know, you go through the gamut, you've got expansion. So all that will be accounted for in their setpoint count.

And you'll see any additional -- I mean, right now, they have what they believe they're going to meet. So, you know, they've defined their setpoint. And now, they've got to get the instrumentation to fulfill that. And any of those type of process PMA effects or whatever will be accounted for. And it might have to adjust the setpoint, or it may not work, but --

MEMBER REMPE: It may need some sort of time-dependent calibration --

CHAIR KIRCHNER: Joy, their piece of equipment in that, say, a safety-related sensor going into the module protection system is going to have to be likewise qualified. This is not unique.

MEMBER REMPE: This radar-based --

CHAIR KIRCHNER: This might be a unique detector, and they're going to have to develop it, and then they're going to have to qualify. But that same range has to be done for every single instrument that feeds into the MPS. So, this is no different.

MEMBER REMPE: I guess when we've done instrumentation for the ATR, we had to think about something that is a bit different. If you have a standard thermocouple, you don't have to worry about some of these things. If you have an irradiation -- I didn't see anywhere in the discussion on the sensor about any sort of concerns with radiation effects over time with the sensor.

It's just this is a little bit different than a DP cell or an RTD, or some of the other things people are --

CHAIR KIRCHNER: Every other instrument has to survive the environment and be qualified for that.

MR. ASHCRAFT: Let's --

CHAIR KIRCHNER: And they're going to see radiation over time. All the other instruments as well.

MR. ASHCRAFT: That's part of the phase four qualification.

CHAIR KIRCHNER: Yeah, that's part of the EQ.

MEMBER REMPE: I didn't see the flux gradient, just the temperature gradient discussed.

MR. ASHCRAFT: Well, I don't know that that's part of the EQ qualification.

MEMBER REMPE: And, so, how will -- if it's not part of the qualification, how will they have confidence that the sensor is going to be accurate during a transient?

MR. ASHCRAFT: Well, so our review, we looked at the ranges, et cetera, to see that they met the GDCs. The rest of it, once they purchase it -- we don't know what they purchase, we're not even sure what they're looking at, because that's still part of this.

But that's the case of any design. I mean, most previous designs, we kind of knew what the instrumentation was, so it wasn't that big a concern. These are new, but still, that's NuScale's issue of putting the equipment to monitor their design.

MEMBER REMPE: Okay.

MR. ASHCRAFT: Again, if you had an idea of what it was, I would agree with you, and it would be part of the normal concerns, but they brought in a widget that's a little different, and I didn't see any discussion in the report or in the staffs. Because, again, the staff's been kind of thrown something that keeps changing with time, I get it.

But some of these widgets, it may bring in new issues that haven't been considered.

DR. CORRADINI: But, I guess, I'm not understanding your concern. Is your concern that it is new? Or you're concerned that they have to make it in this current environment, and it's new?

MEMBER REMPE: It's because that it's new that it brings in some new issues that I didn't see identified in the topical report or in the staff's qualifications. And, of course --

DR. CORRADINI: So, it's more a matter of documentation from your standpoint?

MEMBER REMPE: Yeah. And again, when you bring in a new widget, then you need to be cognizant of it. And so, what's going to happen is -- I would think, again, if they were not a -- which I'm sure they're very concerned and whatever applicant.

But an applicant could say, hey, I'm at the peak temperature, I met the peak exposure limits, and they don't even think about is the flux going to be tailored similar to what the flux is in the core? Is the temperature gradient going to be similar to what the temperature gradient in the core is during normal operation as well as accident conditions for DBAs?

That's what I am concerned is that the widget's a bit different, and the exposure -- or the qualifications that are listed, which are typical for sensors haven't been thought about enough because this widget's different.

CHAIR KIRCHNER: You're presupposing you know the design, and then, you're imposing some additional EQ program on them. I don't see where this is any different than any other instrument.

It may be new. It may be novel. We've registered that concern already in one of our letters, but they have to go through this process. And I think they'll --

MEMBER REMPE: But the process may need extra rigor because the widget's new.

MEMBER SUNSERI: But my experience on the instrument setup is there's going to be a scaling calculation, and it's going to be very detailed. It's going into the manufacturing details of the insurance. It's going to get into the sensitivities of it. It's going to get into the environmental influences on it, and that'll be at an extremely detailed calculation of all those influences resulting in how am I going to calibrate this instrument in the field to support the plant? And there could be a cold calibration. There could be a hot calibration associated with that. It could be -- you know, it just depends on what the technical requirements of the manual are.

MEMBER REMPE: So they did not --

MR. ASHCRAFT: But those scaling calculations are very detailed.

MEMBER REMPE: So they did not consider -- explicitly say they have to pick an irradiation resistant widget that does not transmute with time, which can affect the speed of sound if it were an ultrasonic thermometer in the material as a function of time? You calibrate when you first start up. You might calibrate it sometime, but you don't calibrate that it can change during the exposure?

MR. ASHCRAFT: If the manufacturer says they need --

MEMBER REMPE: Yes, sir.

MR. ASHCRAFT: Trying to turn to the --

MR. PRESSON: Matthew Presson with NuScale Licensing. I just want to introduce Brian Arnholt to the conversation if he is available to talk to some of us. And again, with a quick reminder that this is open session, in case any those details are prop.

MEMBER REMPE: Okay.

MR. ARNHOLT: Yes, good morning, this is Brian Arnholt with NuScale Power, I can answer generalities. But because this is an open session, I can't share, obviously, some of the more detailed information you may be looking for. But we have found vendors who, at this point in time, can meet our accuracy and performance requirements that we've established that Joe Ashcraft had been talking about.

So those concerns, I don't know are concerns moving ahead in the future, and then we'll go and do different kinds of testing to verify that we can meet those performance requirements.

MEMBER REMPE: So, I have looked at your topical report, and without talking about any sort of specifics that are proprietary, I didn't see anything that talks about a flux distribution or a temperature distribution. I saw peak values.

MR. ARNHOLT: As part of the qualification program, we describe, you know, what we will meet in, in the DCA chapter seven. And then, the qualification criteria are spelled out in chapter three. I guess I'd need more information. I understand your concern. But I don't know where in the qualification program those requirements are spelled out.

So I guess I'd maybe need to get some more information on what the question is.

MEMBER REMPE: The reason I'm bringing this up is because this device -- again, my experience is extrapolated from ultrasonic thermometers, which I'll acknowledge, this may be different, but you're shooting some sort of electronic signal down through this waveguide. And if you did that with an ultrasonic thermometer, you would be looking at the flux distribution that can be experienced in a test reactor, which is better known because you plan for that.

But in an operating reactor, you've got to consider different conditions, and you need to -- you know, I didn't see anything about you're going to have some material that will not transmute with time.

MR. ARNHOLT: Okay, I certainly understand the concern. And again, without going into proprietary details, I don't know that I can share any more. But I can share the particular -- one of the particular sensor manufacturers we've been working with has done -- this technology has been in use over the last 20 to 30 years. In fact, there's been some development in the NRU program back in the 1980s.

So we'd just have to follow up with our manufacturers --

MEMBER REMPE: Okay.

MR. ARNHOLT: -- and, you know, explore those types of questions.

MEMBER REMPE: So I'm glad you're aware of it, and verbal stuff's great. I just kind of wonder if maybe some sort of discussion is needed because, again, we've talked throughout this week about that the staff here today may not be the staff that's going to be around to look at what the COL applicant provides. And this is going to be deferred to the COL applicant eventually, and the staff who is evaluating at that time.

MR. ASHCRAFT: Well, similar to Vogtle -- so we supported their inspections of their setpoint methodology and calcs. Oh, I'm sorry.

So this is similar to Vogtle where the actual calcs because they hadn't specified their equipment when we did our review, we didn't know. But we support the inspectors for those typical ITAAC closeouts, or even, you know, whatever inspections they do on that.

So if -- that's when we'll look at their scaling and everything --

MEMBER REMPE: I just would feel more comfortable because, we, may be a different person.

MR. ARNHOLT: Well, I understand that, but I'd like to think that we're grooming the future.

MEMBER REMPE: But if I'd seen something about, you know, radiation resistant, considering gradients in temperature and flux gradients to which the sensor will be exposed during normal operation, as well as accident conditions, I would have more confidence.

MR. ARNHOLT: Well, you know, you would have to -- in their phase four environmental qualifications, I mean, that's when that'll be taken care of. And we don't review that now. I mean, this is a year or so in the future. I don't know exactly when.

MEMBER REMPE: Yeah, I'm just -- I'm saying that it'd be good to see something along those lines in the text somewhere.

CHAIR KIRCHNER: That's part of normal --

MEMBER REMPE: Charles, how do you feel about this? What would the Navy have done?

CHAIR KIRCHNER: This isn't the Navy, I'm going to intervene. We've taken now almost 25 minutes off schedule. There is a process, Joy, that has to be followed. After they do the proof of concept and development, they have to qualify. They're going to have to qualify for the environment. And this is not different than what's done as Joe points out at Vogtle.

So, I think the point has been made, and we've flagged it in previous letters, and I think at this point, I'd like to go back to the schedule and thank Joe and get the NuScale up so we can pick up chapter 20.

MEMBER REMPE: Thank you.

CHAIR KIRCHNER: Thanks, Joe.

We've used a lot of time. Matthew, are you going to make the introduction, or are we going to go right to Jim?

MR. PRESSON: I think we will go right to Jim for this. Keep it briefly.

CHAIR KIRCHNER: Jim, do you have your microphone there on? I can't see you.

MR. OSBORN: Yeah, the green light's on. Can you hear me?

CHAIR KIRCHNER: Go ahead, Jim.

MR. OSBORN: All right. Very good. Good morning.

My name is Jim Osborn. I am NuScale Licensing. Chris Maxwell is back on the phone, I believe, and he is the SME related to these issues.

MEMBER BLEY: I'm sorry. I don't know your jargon. What's an SME?

MR. OSBORN: Oh, subject matter expert.

MEMBER BLEY: I got you.

MR. OSBORN: Sorry.

MEMBER BLEY: I should have known it.

MEMBER SUNSERI: Jim is an aggie too, so he's tough as nails.

MR. OSBORN: Thank you, man.

So, I'm just here to present some of the concerns related to the -- brought up by this committee. So NuScale has revised DCA chapter 20 to include pointers to the three tables at the end of Section 20.1.

In addition, footnotes were added to these tables to clarify that instrumentation used to monitor various parameters are not relied upon for the event mitigation but would only be a supplementary capability.

So the following slides actually show the actual markup of our DCA, indicating the changes we have made. So this slide just shows section 20.1.3 and that pointers were added to the appropriate places to the tables at the end of the section. So you can see the edits there in green and -- or the red/green revisions.

And so the next slide shows the markup that a new table footnote was inserted to reiterate that this monitoring instrumentation is not required nor relied upon, right? And you can read the footnote there. It basically copies text from other parts of the DCA and ties it here to clarify that this is not relied upon.

The following slide. Two other tables --

MEMBER BLEY: I'm sorry.

MR. OSBORN: Yes, sir.

MEMBER BLEY: It's not relied upon in your safety analysis. If you put it in there, it will be relied upon by the operators. No matter what we say, they're going to use it.

MR. OSBORN: If the capability is there --

MEMBER BLEY: It seems a little easy to misunderstand what's being said, but I know what you mean.

MR. OSBORN: It's not relied upon in the safety analysis, right, or in the actual accident analysis. It's obviously -- if the instrument is available, the operators would be able to use it.

MEMBER REMPE: In other parts of somewhere in the documentation, you have the words that it provides additional assurance to the operators even though they don't need it. And that's kind of -- again, that's why I cause trouble about this. Without what he's done, it looks like that they were assuring the functions established.

But the other text -- and now I've forgotten where that other text is, whether it's in the DCA or the SEs or both, but anyhow, that's I think the way you want to characterize it.

MR. OSBORN: Right. So anyway, yeah, so

the footnote says it's a supplementary capability if it's actually available. So that's the --

MEMBER BROWN: Can I --

MR. OSBORN: Yes.

MEMBER BROWN: I'm trying to understand your footnotes. Footnote one says monitoring is -- none of this stuff is needed for the mitigation strategies and guidelines. Is that the way I'm supposed to be reading those because that applies to the whole table?

MR. OSBORN: Yes, sir.

MEMBER BROWN: All of these sensor -- all this data is not relied upon for any of the mitigating strategies?

MR. OSBORN: That is correct.

MEMBER BROWN: Then notes two and three, or at least two, says, by design, once the function is established, they're maintained indefinitely.

I mean, it sounds like somebody is looking for something somewhere that you're going to be trying to establish them. And if they don't, you don't care? Is that --

MR. OSBORN: So --

MEMBER BROWN: I maybe use the wrong words. When I said, don't care.

MR. OSBORN: Yeah, well, it's the functions are established, right? That's not a reference --

MEMBER BROWN: But what do we mean by the functions? Like containment water level under ECCS decay heat removal, that one's got the little three, with the red two marked out. Spent fuel pooled provides indication of these things, but if you don't have spent fuel pool level or containment water level, it's not relevant to any of the strategies at all?

MR. OSBORN: Yes, sir.

MEMBER BROWN: Okay.

MR. OSBORN: That is my understanding. Chris, you can correct me if I'm wrong.

MEMBER BROWN: No, I just want to make sure we understood the notes. If I turn -- all this stuff is not working at all, when we go into the mitigating -- it's just if we're okay. And I just wanted to make a nice clear declarative statement, that's all.

MEMBER REMPE: After ---

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: Before you go too much down that rabbit hole. You were not here this week. At least I am extremely worried about boron redistribution during progression of some events. And by now I think there are more people than me that are worried about that.

And the solution to those problems is in what we call recovery, where instrumentation is used to prevent bad recovery from going bad. I would almost call that mission-critical.

And will the resolution of those issues might affect this? And I guess Matt is ready to answer.

MR. PRESSON: Yeah, and the separation between that is more of a kind of listed here the mitigation versus what you would do post-mitigating whatever event that is. So once you reach that point where you're stable for Chapter 15 DBA assumptions, then we're looking to reestablish whatever you need to recover.

MEMBER MARCH-LEUBA: We may have to write our letter, at least add the comments to the letter more strongly. You didn't hear the Thelma and Louise analogy, but what he calls a safe, stable situation is Thelma and Louise driving in a dirt road, happily in their car not knowing there is a precipice right there, which comes from the sequel of the movie.

So, while you will call -- I will not call that a safe and stable situation. Recovery is part of getting you out of it. So we need to think clearly about it, but I would not call the situation -- if the boron has redistributed, that is not a safe and stable condition. You have not mitigated the event, then.

MR. PRESSON: But if there is nothing to perturb it --

MEMBER MARCH-LEUBA: How do you know? You're not looking at the instrument? You don't have an instrument?

MR. PRESSON: Well, that's --

MEMBER MARCH-LEUBA: You don't know when the level can rise.

MR. PRESSON: And that's part of why you're looking to after you've established that, it's post-accident space.

MEMBER MARCH-LEUBA: If you rely on some instrumentation for the recovery phase because you are on the border of the precipice, you're driving towards the canyon. And while you're driving towards the canyon, you're safe and stable, but eventually, you may get there.

You guys need to think long and hard about -- because if the boron redistribution is not an issue, because you cannot get there, which is one argument -- one likely argument, I would say. Then you're right.

But if it is not, then you're not right.

MR. PRESSON: If we are not, then we have additional concerns that we have to work with during recovery, and you would certainly want to have various monitoring options available to you. But so long as you are not, there's not another transient to perturb what your condition is, then you've reached your design-basis accident requirements.

MEMBER MARCH-LEUBA: Yeah, I certainly reserve the right to review your condition report. I will certainly like to see what you come up with before we write a letter because I don't think you are in a safe and stable condition when you're driving down a dirt road.

MR. PRESSON: Which is understood, definitely.

MR. NOLAN: This is Ryan Nolan with the staff. Can I try to provide a little bit of perspective? So chapter 20, and what you're seeing here is really how does the design and the future applicant how will they comply with 50.155? That's the beyond design-basis external-event rule.

And so, the assumptions that we use to

address maybe chapter 20 is a little bit different than what we would do under chapter 15. What you're seeing here is the mitigation strategies piece of the requirement for 155. Recovery is well beyond that. 155 requires indefinite coping and mitigation strategies.

A recovery is a much later activity. And that's defined by providing an alternate means of heat removal that can be through commissioning of new SSCs, repairing existing SSCs. And so, if -- the way that I see this as a recovery, you would assume you have the power and the instrumentation available to take those actions and the instrumentation doesn't even have to be permanently installed.

According to 155, you could use portable -- you can take remote readings to gather whatever information you need to take appropriate action.

MEMBER MARCH-LEUBA: But I can imagine actions not taken by the operator that will get you out of that safe and stable state. So, what you call mitigation -- if the boron resolution happens, which is an if. We have not done the thorough analysis to guarantee what will happen under this condition.

Once you have redistributed the boron, and you have cold un-boronated water ready to go into the core. You have to guarantee that the riser will not recover level, or the containment doesn't dump water on top of the outcome and pushes. Or that you don't overheat -- did you reheat the primary and the level rises by itself?

There are three ways you can get out of that safe, stable, and I'm using quotes around that, state. The fact that you said that you mitigated it depends on you keeping the level below the riser.

MR. NOLAN: Right, this is demonstrating compliance with 155.

MEMBER MARCH-LEUBA: I'm not sure. I mean, I've never even read 155, okay? But defining a safe and stable condition that may not be safe and stable is worrisome to me.

I've been repeating this for the whole week, so I'll leave it right there.

MEMBER BLEY: Well, let me add to it because, in various kinds of analyses, we don't go beyond a certain point in the transient, but recovery can lead you into great troubles. And if you want an example, you don't have to look far back. Look at the Robinson fire.

After that whole event was over, they reset the 76 relay and created a new event, in some ways worse than the original event. It can happen, and thinking about those things ahead of time helps you avoid it.

MR. NOLAN: And just I guess one more point to add. The staff's review was only for the first 72 hours. And in the safety evaluation, we documented that if there are any credible transient phenomena which could impact the safety functions that would be reviewed during the COL.

Another point to add is because this is a beyond-design-basis scenario. The assumptions are different than what was used in chapter 15 when these transients were analyzed. And so that we would look from a realistic nominal all rods in, ultimate heatsink, temperatures would be what we would expect, you know, in the long term which could be boiling conditions.

MEMBER MARCH-LEUBA: My goal in life this week was to bring visibility to this issue. And I think that nobody claims to be ignorant about the issue anymore. So I think -- I declare success. And we'll see what you come back with when you analyze the event.

MEMBER BLEY: But that last statement, while perfectly reasonable, left a vague if any situation should exist, we'll look at it later. Well, you've been advised of one situation here. So, it's time to make sure we don't lose it.

MEMBER MARCH-LEUBA: I can think of three different situations once you get into this, hitting the vessel by any means, inadvertent actuation of our supply of water like CVCS, or opening the containment with a lot of water level in there like it will happen automatically.

So I can think of three things that can get you out of that safe and stable condition. I don't see why we're postponing this to a COL when we're certifying our reactor now.

And I say, I've achieved my goal, and I'll shut up.

DR. SCHULTZ: And just one more comment. NuScale has set up the CR to investigate other things that we haven't thought about. But they're going to examine to see whether there are other issues that need to be addressed.

And if they go into affecting this aspect of the design, then they'll need to follow that too, a corrective response -- action response should be sure to identify that.

MR. PRESSON: We will definitely look to

include any FSAR changes through that.

CHAIR KIRCHNER: Jim, I wanted to go back to Charlie's question just to clarify, and then I want to make sure Joy -- this has addressed the issues Joy previously raised.

I'm looking at the footnotes. You've got five. It's a good one to use. You say footnote numbers two and three in green now, by design once these functions are established, they are maintained indefinitely.

What you are saying here in chapter 20 space is that basically, you will indefinitely maintain of capability to measure the spent fuel pool level. Is that how I read the footnote?

MR. OSBORN: So, the first column of the table is the function. So, the function that's -- once it's established will be maintained indefinitely is that inventory control or activity control, heat removal. Those are the functions.

CHAIR KIRCHNER: Yeah, I understand that. But the right-hand column seems to imply to me, and I just wanted to understand the footnote that you will measure spent fuel pool level by whatever means indefinitely.

MR. MAXWELL: Jim, this is Chris Maxwell

of NuScale Power. I just want to say that's correct. There's a requirement for a 50.155 echo for spent fuel pool level.

CHAIR KIRCHNER: Exactly.

MR. MAXWELL: What you're saying, it's exactly correct.

CHAIR KIRCHNER: Okay. Does that address your question, Charlie?

MEMBER BROWN: No, actually between the conversations from staff and NuScale, we toss these terms mitigation and recovery around. So, I went back and read again the chapter 20 lead-ins, where it says there are no mitigation strategies at all were tried for NuScale because they're an applicant, not a COL.

Well, I mean, that's in the first two paragraphs of chapter 20. But I'm still kind of lost on something happens you take -- to me, these are my thoughts based on when we did all this, a mitigating strategy tries to try to stop what's going on and put you into a condition where you're safe.

Recovery is now what do I do longterm? And do I have to bring certain functions back and stuff like that? And I don't quite understand how that conforms with the wording on the table in terms of mitigating and recovery, so I just kind of got lost with the words about what's indefinite and what's not. Either that or I'm not reading it properly.

MEMBER MARCH-LEUBA: I don't think this table addresses recovery at all, about whether there is it's a different beast.

MEMBER BROWN: Well, the indefinite -- I guess, I would have disagreed with -- I'm not disagreeing with you, I'm just saying that's not my understanding when I read the words in notes two and three.

MEMBER MARCH-LEUBA: I absolutely --

(Simultaneous speaking.)

MEMBER BROWN: The words indefinitely mean, indefinitely. That's a long time. That's months. That's not a few hours. And that's not just bringing myself to a safe condition. So that seems to me that's a little bit more all-encompassing than just getting yourself to a safe condition, and nothing else applies to me.

So that implies a little bit more need for systems and/or instrumentation to be available or be able to be made available in order to do that longer-term thing, and that sounds like that's -- there's committing to that, but yet the words say they -- in the beginning of the chapter say, they don't have to.

That's kind of the way I read it. Now, I, again, I read words as words, not as thought -- not as Gedanken experiments. So, anyway, that's that was why I brought it up. That was all.

CHAIR KIRCHNER: Joy?

MEMBER REMPE: Well, recall, though, the history of this. They originally wanted 30 days. Even though they don't have to do anything, they did this for regulatory certainty or something. And the staff said, yeah, we're just going to look at for 72 hours. So even though they say indefinitely, the staff only bought off, and that's all we care about for 72 hours at this point.

So I think your concern is -- or should be rephrased Charlie to do you have confidence that they're going to stay in a stable state for 72 hours? And so that's why I'm okay with all this. There's an underlying assumption for assuring the function is established is that the COL applicant will have procedures that will help them understand how to assure that the function is established, but that underlying assumption has been hard to find repeatedly in the last week about that those procedures don't exist.

Maybe they do, but they're not part of this process. But that is there that they have to establish this and how they determine it and how they check off and say, yes, it's good.

MEMBER MARCH-LEUBA: Ryan, can I ask you a question? These 72 hours is the position of the staff that a plant is passive and doesn't require operator actions as long as you can do it for 72 hours? And after 72 hours, we go into chapter 19-type rules where the operator is going to do something even if you are in a very outside scenario. There is going to be power even it has to be flex power. Is that the position of the staff, that a passive plant is passive for 72 hours, not forever?

MR. NOLAN: Yes, that certainly was part of the consideration, mostly as documented in the SECY paper that was drafted on the topic. We wanted to try to maintain consistency with what we did for the other new reactors, as well as make a finding on what we feel we should be making a finding on at this point.

MEMBER MARCH-LEUBA: Yeah, from the point of view of setting a precedent for other plants, I think it would be nice if certainly ACRS can take a position on it. But we make it clear that the staff -- that we consider a passive plant and as long as it can cope for 72 hours, and afterward we'll give you credit for things that are like Class 1E because you will bring power back.

MR. NOLAN: Certainly.

MEMBER MARCH-LEUBA: It may take a position from the 14th floor of the other building, okay? But it would be nice to have clarity. Because when you hear Charlie say shutdown means shutdown on GDC 27, it's because he's hearing, I'm going to stay there for the next seven months.

MEMBER BROWN: Then that's the way it works.

MEMBER MARCH-LEUBA: That isn't the way they say it, but what they mean is I want to stay there for 72 hours, and then something is going to happen.

MR. NOLAN: Right, and it could be less than 72 hours.

MEMBER MARCH-LEUBA: Yeah, sure. But it would be nice to have clarity, not for NuScale but for all the old reactors that are coming along. So we'll have to fight this again.

MEMBER BLEY: Well, we ought to talk about that ourselves at some point. You know, the last letter we wrote on this disagreement that Joy spoke about, I think we just urged the staff and the industry to get together and work it out, and we weren't strong on it, but one thing that affected us was the industry program that led to safer and that ability to bring equipment and support to plants.

Now, when we get to talking about it, I'm not sure some of these smaller, newer plants are going to join up in that process, so the assumptions that we've had about where help comes from and how fast are linked to people being part of a larger program, and we don't know yet if these small machines will be included in that, so it's premature for us to decide things, I think, in that area.

MEMBER BROWN: Just let me restate if you read the notes, monitoring is not relied on for the mitigating strategies and guidelines, but installed instrumentation provides at least 72 hours of module monitoring and at least 14 days of UHF. Ultimate heat sink monitoring is supplemental.

Then the next notes say but they're going to be maintained indefinitely once they're established. There's just --

MEMBER BLEY: They're functions.

MEMBER BROWN: Well --

DR. CORRADINI: You're bothered by the

incongruity of the two, of the added statement to the other statement. That's what I hear you --

MEMBER BROWN: Yeah, yeah, there just seems to be a dichotomy between the two.

DR. CORRADINI: I think the understanding, at least from the staff's explanation, is indefinitely is up to their decided time, or the way Joy said it, I think, is best, 72 hours is indefinite up to this point in time.

MEMBER BROWN: That's not the way I've heard it said.

MEMBER REMPE: I said it doesn't matter what they put in their DCA. What we agreed to, what the staff agreed to is 72 hours, and we review the staff stuff and it, you know, so what? They could have claimed that they're going to do it until kingdom come, you know.

That's kind of where I'm at on it, but, you know, again, I get where you're at, but when they -- you know, if they hadn't added the footnote and changed some of this, I would have gotten -- I did get more concerned.

MEMBER BROWN: I'll shut up.

MEMBER MARCH-LEUBA: I want to ask a question. Administratively, is this going to be incorporated on the phase six FSAR, I mean, the final one?

MS. OSBORN: So, these changes are planned to be part of Revision 5 of the DCA.

MEMBER MARCH-LEUBA: Which would be, from the staff, it would be phase six or is there such a thing?

MR. NOLAN: Yeah, so we had an opportunity to look at these changes and they did not alter our understanding of how the instrumentation was being used as part of the mitigation strategies or not being used as part of the strategies, and so we don't see a need for the safety evaluation to change.

MEMBER MARCH-LEUBA: Yes, sure, but, so this is a gentleman's agreement then kind of or --

MR. NOLAN: The changes don't affect the safety evaluation.

MEMBER MARCH-LEUBA: I know, and I completely agree that this is a solution for a concern that we had --

MR. NOLAN: Right.

MEMBER MARCH-LEUBA: -- that they're fixing for us. So, you have a process to get this thing through and get the final signatures?

MR. NOLAN: Yes, yeah, and we'll confirm

that these changes are incorporated.

MEMBER MARCH-LEUBA: As long as you have a process, I'm happy.

MEMBER BLEY: Well, from what Jose just raised, we will be writing our final letter at some point based on, some point fairly soon based on our understanding and reviews of documents.

In the past, it has happened that there has been another revision to a DCA after our letter and I think in all of those cases, the staff has brought that back to us and said, "Does this make a change for you?" and usually it hasn't.

It's been, if not editorial or other things, then we just send a note back saying everything is fine, but at least we get a chance to look.

CHAIR KIRCHNER: Okay, Jim?

MS. OSBORN: Yes, sir?

CHAIR KIRCHNER: Do you have any more to present?

MS. OSBORN: This is it. Not for this topic, no, sir.

CHAIR KIRCHNER: Okay, members, further questions? Joy? Okay, at this point then, does the staff wish to make any -- Omid, any further comments on this?

MR. TABATABAI: Yes, good morning. This is Omid Tabatabai. I'm the project manager for Chapter 20. I think we discussed, as Ryan mentioned, we looked at the changes that NuScale has proposed and they have provided these markups on the docket, so it's already been docketed for March.

So, they will be incorporated in phase five, in Rev 5 of the DCA, thank you, and we don't have a need for changing anything in our SE. So, at this point, unless you have any other questions, we have no slides to present.

MEMBER MARCH-LEUBA: At least administratively, the SE is a recommendation to the commissioners that they approve it, right? So, it is their final signature that really carries the weight of law. Your SE, your recommendation doesn't change.

MR. TABATABAI: That's correct. Our conclusions and recommendations don't change.

MEMBER MARCH-LEUBA: But the approval really comes from the commissioners.

MR. TABATABAI: Understood.

MEMBER REMPE: I guess I have a question now. The process is new. What's my next step? I wrote a memo to Matt saying, "Hey, something ought to change with Chapter 20," and something changed, do I have to do anything else? Does ACRS have to do anything else or are we just done?

MR. SNODDERLY: I don't believe so. It's an individual member comment to the chairman, and now, and the committee is aware of it and they will decide whether to adopt it and do anything further or to let it stand alone as it currently does.

MEMBER REMPE: Sounds good. Maybe in the minutes of some full committee meeting or something, you could say that this was done and reviewed or something is all -- I'm kind of wondering how we document this for the public, or if somebody looks at this --

MR. SNODDERLY: I think it's on the transcript right now. If we have a transcribed meeting, then the public is having the benefit.

MEMBER BROWN: Walt?

CHAIR KIRCHNER: Yes, sir?

MEMBER BROWN: I wanted to, if I could, I wanted to backtrack to the earlier discussion --

CHAIR KIRCHNER: Yes.

MEMBER BROWN: -- on instrumentation to make sure, because I heard two different, thought I heard two different statements about the detector. Is

Joe still here?

CHAIR KIRCHNER: I think he had to leave. That's why we --

MEMBER BROWN: Well, NuScale is here and the other staff is here. I think that will work. The comment was made that the detector for containment water level and/or if it was RPV, a reactor pressure vessel, riser level was safety related. I think Joy said that and everybody said that.

CHAIR KIRCHNER: Yeah.

MEMBER BROWN: But then the comment was made that the function was non-safety related and I just -- the containment water level sensors feed and trigger ECCS, so they feed the MPS. That means it's a safety-related function.

CHAIR KIRCHNER: Yeah.

(Simultaneous speaking.)

MEMBER BROWN: I'm just trying to make sure you understand that the output of the detector goes through, you know, a categorization and then it goes into the MPS. It's one of the coincidences, you know, redundant coincidences, two out of four sensors for triggering ECCS --

CHAIR KIRCHNER: So is the --

MEMBER BROWN: -- which is protection

related.

CHAIR KIRCHNER: So is the component of the reactor vessel's level sensor in the pressurizer.

MEMBER BROWN: Yes, yeah.

CHAIR KIRCHNER: Just the pressurizer, so they've dropped the RPV measurement as --

MEMBER BROWN: Two different sensors that's --

CHAIR KIRCHNER: -- part of their triggering, but the upper part measuring what the pressure level is also does a similar --

MEMBER BROWN: Yeah, but pressurizer level, containment, and water level --

CHAIR KIRCHNER: Right.

MEMBER BROWN: Okay.

CHAIR KIRCHNER: Both go into the modular protection system.

MEMBER BROWN: Both sensors, they both go into the modular protection system and they're --

CHAIR KIRCHNER: Right.

MEMBER BROWN: Therefore, that whole function is a protection-related function.

CHAIR KIRCHNER: I think that's understood at this point.

MEMBER BROWN: So I'm just --

PARTICIPANT: That's correct.

MEMBER BROWN: I wanted to make sure all of these --

MEMBER BLEY: I think the function they're talking about that was not safety related is the instrument panel where you read those --

MEMBER BROWN: Well, when you take it out of the MPS, it goes to the main control room and is on the panels. That's a safety related --

MEMBER MARCH-LEUBA: Why don't we let Matt clarify?

MR. PRESSON: So, yeah, you have the, your two sets of sensors for containment for the reactor vessel. They both have safety-related functions. They are both safety created sensors for the sensors that are within the reactor vessel.

They have two functions. One is that pressurizer level, which is a safety-related function, and one if the RPV level and that is no longer a safety-related function, so that's how --

MEMBER BROWN: It's still there, but it's not --

MR. PRESSON: It is still there.

MEMBER BROWN: Yeah, I got that.

MR. PRESSON: Correct.

MEMBER BROWN: Yeah, it's no longer used to trigger ECCS.

MR. PRESSON: Right.

MEMBER BROWN: And therefore, it can be decoupled, uncoupled from the safety-related function aspect, but pressurizer level is an all the way through.

MR. PRESSON: Yes.

MEMBER BROWN: It's safety related clear through the display. I mean, you have multiple channels to be selected from in order to maintain some idea of what the levels are. Okay, I just --

MEMBER REMPE: So, there's this table.

MEMBER BROWN: I understand that. I was listening to the words that got put into the transcript.

MEMBER REMPE: Yeah.

MEMBER BROWN: I just wanted to make sure it was certain what was what --

MR. PRESSON: Yeah.

MEMBER BROWN: -- as we articulate it. That's all.

MR. PRESSON: Yeah.

MEMBER BROWN: Thank you.

MR. PRESSON: That's right. Thanks.

MEMBER BROWN: Sorry to backtrack.

CHAIR KIRCHNER: Okay, at this point then, I think we're ready to transition topics and go to Chapter 9 and hydrogen and oxygen monitoring. I don't know if you, Matt, are you going to present those together or do you want to break them up?

MR. PRESSON: They'll be presented together.

CHAIR KIRCHNER: Together, okay.

MR. SNODDERLY: This is also for the benefit of the members of the public. There's been some -- it's hard for them to follow, so if you could let them know what slide you're on once in a while?

MS. OSBORN: Sure.

MR. SNODDERLY: It would really help the members of the public. So, for members of the public on the line, we're now going to begin the NuScale Topic Hydrogen Monitoring Slides.

CHAIR KIRCHNER: Jim, are you going to present --

MS. OSBORN: Yes, sir.

CHAIR KIRCHNER: -- this as well? Okay, we're having us sign. Here they come, Charlie. Okay, go ahead, Jim.

MS. OSBORN: All right, we're ready? So,

yeah, I was going to introduce -- I'm Jim Osborn again and this is Matt Presson, so we'll be doing the presentations here. So, I'm on the introduction slide, slide three.

So, as a way of introductory remarks, one of the issues raised by this body is a concern that in the NuScale design, there is a potential that radionuclides from an accident source term could be processed through a non-safety-related system.

It should be recognized that this body has already approved or at least recommended for approval such a concept in many other existing designs. This has been approved because the rules of analysis for beyond design basis accidents allow for the use of non-safety-related SSCs for accident mitigation.

This presentation will attempt to explain this regulatory framework under which the hydrogen monitoring system design was developed, and explain some of the details of the design so this body can understand and appreciate how the design is in compliance with the current regulations similar to many other designs in the current fleet.

So, we will start with explaining the overall paradigm of the design basis versus beyond design basis framework and the differing rules for accident mitigation for each category.

Then we'll clarify aspects of timing of these severe accident scenarios related to developing combustible mixtures that are detrimental to containment, and then we'll also discuss some of the operational decisions for actually initiating hydrogen monitoring in a beyond design basis event.

And then next, we will discuss the implications of this design basis versus beyond design basis framework on radiation protection issues, and then the monitoring equipment's capability to withstand combustion events in containment will be presented, and finally, we'll explore the topic of containment mixing and representative monitoring. Next slide.

CHAIR KIRCHNER: Jim?

MS. OSBORN: Yes, sir?

CHAIR KIRCHNER: May I interrupt and just make an observation? We understand the rules. We understand that this is similar to what was done, is done in the current fleet. What our principal issue was in a risk-informed manner, is this -- let me say it shorthand. Is this the best approach to addressing the issue?

So, yes, continue through. Walk through

the framework that you just outlined, but I just wanted to make the point that we understand that framework, but we were looking at it from the perspective, is this the best risk-informed way to operate the system?

MS. OSBORN: Okay, and --

CHAIR KIRCHNER: That's shorthand, okay?

MS. OSBORN: Yes, sir, and --

CHAIR KIRCHNER: Please continue.

MS. OSBORN: And part of this presentation will address the risk question, as I believe the staff's presentation will also, okay.

All right, so, slide four. For the design of a nuclear power plant, including NuScale, there are many events that are required to be evaluated by an applicant.

For events that are classified as accidents, there are two broad categories, design basis and beyond design basis. The definitions provided on these slides are just copied from the NRC website.

So, as it says, a design basis accident is a postulated accident for which a facility must absolutely be designed to withstand by meeting certain criteria, including radiological consequence criteria.

A beyond design basis accident is an accident sequence that is possible, but because it is unlikely, the design process does not fully consider all of the implications and ramifications of such an accident.

These accidents are therefore not fully designed for or fully evaluated as is the case in a design basis accident, so when you're considering a beyond design basis accident, there is a different regulatory framework which is to be viewed. Next slide.

So, the rules for evaluating a design basis accident include several considerations for a particular SSC that is credited for the mitigation of that design basis accident.

For example, a credited SSC might be able, or must be able to withstand a single active failure without a loss of its mitigating function. Therefore, such an SSC might have two trains or have two power supplies in order to maintain its mitigating function upon a single failure.

Similarly, an SSC is required to be safety related, a higher quality pedigree to ensure that it has procured, maintained, and installed consistent with 10 CFR 50 Appendix B.

The SSC is also required to be seismic category one to ensure that it can perform its safety function upon a design basis seismic event. If that SSC that is being credited requires electrical power to perform its safety function, that power source must be a 1E power source.

That is why the NuScale design does not have any 1E power sources, because none of the SSCs credited for the design basis accident mitigation require any electrical power. This is why the power provided for the hydrogen monitoring system is also not 1E power.

Therefore, a nuclear facility's safety analysis, an SSC credited in mitigating a design basis accident must be appropriately categorized and designed, else it cannot be credited.

That is why the accidents in Chapter 15 are evaluated as they are, but beyond design basis accidents are different. Next slide. I'm on slide six.

So, there we go. So, because the category of beyond design basis accidents are considered by the NRC to be less likely as a category than design basis accidents, non-safety-related SSCs can be credited for accident mitigation purposes.

The SSCs credited for mitigating beyond design basis accidents are not required to be safety related, single failure proof, or seismic cat one.

Beyond design basis accidents are a different category because they involve multiple failures often, and the accident evaluations allow realistic assumptions.

That is why the distinction between design basis and beyond design basis accident is so important. It's a different paradigm. The evaluation rules are different because the relative risk is different.

This is also why the NRC revised the regulation relative to hydrogen monitoring to allow the use of non-safety-related equipment to monitor for containment of hydrogen in post-severe accident scenarios.

The NRC decided that it was a low risk system, and therefore allowed it to be non-safety related. The NuScale design has complied with these revised regulations. Therefore, the NuScale hydrogen monitoring SSCs are not safety related. They're not single failure proof. They're not seismic category one, and they have no 1E power supplies.

Other designs also utilize non-safety-related hydrogen monitoring equipment, such as Watts Bar 2, so NuScale is certainly not unique in the industry in this regard.

DR. CORRADINI: But I guess just to echo what I think Walt started the whole thing off with, I don't think, at least from my perspective, we disagree with that, but --

MS. OSBORN: Okay.

DR. CORRADINI: -- your design is unique, so therefore, the evaluation of how you satisfy the requirement, if one wants to satisfy the requirement, is what makes it unique, so I think that's where Walt was going.

MS. OSBORN: Okay, all right, so I'll continue to go through and see if it answers -- yeah, all right, very good.

All right, so I'm on the, yeah, timing of detrimental mixture. So, I'm using the term detrimental mixture here to mean a combustible gas mixture that is capable of actually threatening containment integrity.

In the December 20 letter from the ACRS, it was stated that NuScale has weeks of time before combustible levels of hydrogen and oxygen could be generated. This is true if 100 percent core damage is assumed as the regulations require, but this is not the most limiting case for the NuScale relative to time.

So, to ensure that the analyses are conservative regardless of strict adherence to the regulations, additional analyses were performing using lower, smaller core damage percentages. These analyses showed that there are more limiting cases with respect to time for the NuScale design.

So, NuScale performed a bounding evaluation of the maximum possible combustion event at 72 hours because, as we discussed before, 72 hours is NuScale's licensing and design basis for passive coping period.

After 72 hours, it can be assumed that emerging conditions can be managed by plant operators using non-safety-related equipment under the guidance of severe accident management guidelines and the emergency response organization.

But at 72 hours, the maximum possible combustible mixture is not a detrimental mixture and does not adversely affect containment structural integrity, but under bounding assumptions, bounding case assumptions, there are not weeks of time.

So, therefore, NuScale did not pursue an exemption from the hydrogen and oxygen monitoring regulation because there could be, albeit unlikely, there could be conditions under which such information from the monitoring system could prove useful. NuScale and the NRC staff have discussed this and are in agreement that such an exemption would not be recommended.

MEMBER MARCH-LEUBA: Your exemption from what, from the monitoring?

MS. OSBORN: Yes, sir.

MEMBER RICCARDELLA: Can you explain briefly just physically why it is that smaller amounts of core damage create more of a problem than complete core damage?

MS. OSBORN: Yeah, so when you have 100 percent core damage, you're releasing from the exothermic reaction, right, a maximum amount of hydrogen from the zirc water, so you're essentially hydrogen inerted because there was no oxygen in containment before and the only source of oxygen is through radiolysis, and it just takes a long time for enough oxygen to be developed to create that mixture when you're assuming that much hydrogen.

So, for smaller core damage scenarios, you have less hydrogen, so it takes a smaller amount of time to build up enough oxygen to create that combustible mixture.

MEMBER RICCARDELLA: Thank you.

MEMBER BROWN: But still more than 72 hours?

MS. OSBORN: Yes, sir.

MEMBER BROWN: Okay.

MS. OSBORN: Yes, so we did a bounding analysis.

MEMBER BROWN: For small versus -- I mean, you're not differentiating between small, low core damage and 100 percent? That's what I was searching for. The 72 hours bounds the small even though that's more limiting than the --

MS. OSBORN: Yes, sir.

MEMBER BROWN: -- maximum. That's all I was -- I thought I'd made that point halfway clear.

MS. OSBORN: No, I understand.

MEMBER BLEY: Also, I think I heard you say that in this shorter time, while you're getting enough oxygen, you're getting oxygen, but I think you said it wouldn't be, in your words, a detrimental mixture. It wouldn't damage the containment?

MS. OSBORN: That's correct, yes, so --

MEMBER BLEY: So, it's --

MS. OSBORN: -- a combustible mixture is possible.

MEMBER BLEY: Having this shorter time envelope, you're getting a combustible mixture, but it isn't going to hurt anything?

MS. OSBORN: Right, containment will still maintain its structural integrity.

MEMBER BALLINGER: So, you're saying you could get a deflagration, but not a detonation?

MEMBER BLEY: Or a burning anyway.

MEMBER BALLINGER: A burning or whatever --

MS. OSBORN: You get some combustion --

MEMBER BALLINGER: -- but not a detonation?

MEMBER BLEY: And probably not a deflagration either.

MEMBER BALLINGER: Okay.

MEMBER MARCH-LEUBA: Well, I don't think that's what you said, right?

MS. OSBORN: No, I didn't quite go into that detail.

MEMBER BALLINGER: You said detrimental. I'm just trying to figure out what detrimental is.

MS. OSBORN: Detrimental means that you

fail containment.

MEMBER BALLINGER: Oh.

MEMBER BLEY: And that means you've got to have a detonation.

MEMBER BALLINGER: That means you've got to have a detonation.

MEMBER BLEY: A shockwave --

MS. OSBORN: Okay.

MEMBER BLEY: -- if you will.

MEMBER MARCH-LEUBA: Physically speaking, the oxygen is your limiting component.

MS. OSBORN: Yes.

MEMBER MARCH-LEUBA: And it is produced almost at a constant rate by radiolysis because radiolysis is going by how many high energy gamma rays are coming into the core.

MS. OSBORN: That's our assumption, yes.

MEMBER MARCH-LEUBA: And if you could change the number of alphas that come out of the core by geometric changes, it would affect something, but it's almost impossible to do, so alpha is not going to continue.

So, your oxygen generation is constant no matter what, and now you oxygenize the right amount of core so that you get to this stoichiometric relation of H and O that you have produced in 72 hours, and that's your maximum explosion. Is that correct? And that does not -- you understood what I said? So --

MS. OSBORN: No.

MEMBER MARCH-LEUBA: You're producing a constant rate of oxygen every hour.

MS. OSBORN: So, again, and hopefully I have some phone support from the subject matter experts that did this work, but the assumption is that oxygen is produced through radiolysis at a bounding rate --

MEMBER MARCH-LEUBA: Yeah.

MS. OSBORN: -- right? And so there's some discussion that -- you know, radiolysis is a two-way -- it's a chemical reaction, right? And so there's a -- or it's a nuclear reaction with a chemical component that --

Reactions go both ways, and so, but our assumption is that it's only driven by radiolysis. There's no recombination going the other way.

DR. CORRADINI: So you ignore recombination?

MS. OSBORN: Yes.

MEMBER MARCH-LEUBA: So that's a bounding --

(Simultaneous speaking.)

MS. OSBORN: It's a bounding case. That's why I called it bounding is it could not be worse.

MEMBER MARCH-LEUBA: The most oxygen it can produce is this much, and I assume that's how many grams of oxygen I have in containment. I mean, are you assuming it migrates to the worst point, right?

MS. OSBORN: Yes.

MEMBER MARCH-LEUBA: Because it likely will stay dissolved in the water and wouldn't do anything.

MS. OSBORN: Right.

MEMBER MARCH-LEUBA: That's another bounding assumption. And what you do is if you oxidize all of the zirconium --

MS. OSBORN: The zirconium, right.

MEMBER MARCH-LEUBA: -- in the core, you will produce so much hydrogen that you could not explode that oxygen or hydrogen. I mean, it would not be an explosive mixture.

MS. OSBORN: Right, it takes a long time for enough oxygen to become available to create a combustible mixture.

MEMBER MARCH-LEUBA: But if you only fail a couple of pins, or 10 pins, or 100 pins, or however many there needs to be, then you could get a proper combination of H and O.

MS. OSBORN: Right, so I think what we did at 72 hours is figure out how much, what was the maximum amount of oxygen that would be available in 72 hours and then back calculated how much hydrogen would create the worst mixture, and that amount of hydrogen corresponds to a percent core damage.

DR. CORRADINI: So, now let me get to the next step and maybe you need somebody on the phone. And then you did what? You then assumed it combusted.

MS. OSBORN: Yes.

DR. CORRADINI: And the pressurize from that determined to be detrimental?

MS. OSBORN: Was not detrimental.

DR. CORRADINI: It was not detrimental?

MS. OSBORN: That's correct.

DR. CORRADINI: Okay, that's where I was confused.

MS. OSBORN: Okay.

CHAIR KIRCHNER: And that was in the containment analysis, Chapter 6.

DR. CORRADINI: Right.

MS. OSBORN: Yes.

DR. CORRADINI: Okay.

CHAIR KIRCHNER: And that partially informed our position, Jim, because your analyses demonstrated that you would not fail containment.

MS. OSBORN: Right, yeah.

CHAIR KIRCHNER: So, keep going.

MS. OSBORN: For 72 hours, right.

MEMBER PETTI: So, just to be clear, after 72 hours, the letter that was written said many weeks. You're basically telling us that there were some other events that you looked at that was more on the 72 to, I don't know, you know, a couple hundred hours, not a couple of weeks.

MS. OSBORN: Right.

MEMBER PETTI: So that's why you didn't go for the exemption.

MS. OSBORN: Right.

MEMBER PETTI: Because if you can recall, committee members, we had lots of discussions about why didn't they go for the exemption, and I don't think we had this full picture as we deliberated, so this is helpful.

MEMBER BLEY: Yeah, but before you leave that, as I understand what you said, this is not an explosion you're talking about.

MEMBER PETTI: Correct.

DR. CORRADINI: It burns.

MEMBER BLEY: It burns.

DR. CORRADINI: It makes pressure.

MEMBER MARCH-LEUBA: No, wait, wait, is it a burn or does it detonate?

MEMBER BLEY: It doesn't detonate. It's not detrimental, so it can't hurt containment.

MS. OSBORN: It's a combustion event which includes all kinds of things, right, and I don't know if the mixture that we -- is Colin or Scott Weber on the line?

MR. WEBER: Yeah, Jim, hey, this is Scott Weber. Yeah, I wanted to jump in here. So, the analysis that we've been referring to, the 72-hour analysis, that is a deflagration to detonation transition event, so it is eventually a detonation dynamic that is analyzed.

It is not just a peak deflagration pressure spike, and what the analysis has demonstrated is, as you said, the maximum amount of oxygen at 72 hours combined with this stoichiometrically determined hydrogen amount, even considering the DDT, did not threaten the structural integrity of the containment, so that's all agreed upon.

DR. CORRADINI: So, Scott?

MR. WEBER: What we haven't -- yes, please, go ahead.

DR. CORRADINI: So, it's not detrimental at 72 hours. I think Dr. Petti is asking did you perform analyses as to when it would be detrimental?

MR. WEBER: Right, and we did not, no. What we know is the amount of time it would take to reach a combustible mixture with 100 percent fuel cladding oxidation, but we have not specifically determined the amount of time after 72 hours at which you could get a detrimental mixture.

That's why we haven't definitively stated or agreed with weeks of time. We know it is some time greater than 72 hours, but we do not have a definitive amount of time past that.

CHAIR KIRCHNER: So, Scott, this is Walt Kirchner. I remember in the Chapter 6 in the containment analysis that it was deflagration to detonation, and then you did an equivalence analysis to demonstrate that the containment could withstand this pressure pulse.

So, was that -- what wasn't clear to me in reviewing Chapter 6, so that set of assumptions then must have been the 72-hour scenario that you're talking about. I don't think it was -- that was not footnoted in the analysis.

It just was -- which led me to believe reading it that you essentially had 100 percent zirc and then you found an oxygen mixture that would detonate that, lead to a detonation. So, the Chapter 6 analysis is 72 hours? I guess that's my question.

MR. WEBER: Yes, that is correct.

CHAIR KIRCHNER: Okay, that wasn't clear. All right, thank you.

MEMBER REMPE: So, I'm getting confused. You have confidence that there are some events that could fail the containment. You just don't know what the timing of it is? Because Dave is asking --

At first we were told, "Yeah, we've looked at it," and then I think you said, "Well, we've not really looked at it. We don't have a time," but you still have confidence there are some other events out there that could fail the containment. Where are you exactly?

MR. WEBER: What we know for certain is that we've looked at a wide range of severe accidents that can potentially occur for the NuScale design, and not all of them are complete core damage and oxidation. So, we know that there exist accidents whereas you only have partial core damage and less than 100 percent oxidation.

What we haven't ever done is translate that into a specific time and done an analysis to see whether that would be a detrimental mixture. So, we don't know for certainty that we have a specific event that would lead to a failed containment, but we do know that there are severe accidents that do not result in 100 percent cladding oxidation.

MEMBER REMPE: Thank you.

MEMBER BLEY: So that's less hydrogen is what you're saying, so you need less oxygen. I think you also said for the 72-hour calculation that that was, you called it a transition from deflagration to detonation, but then you said the pressure pulse wouldn't damage the containment. If it really transitioned into detonation, you would have also had a shock wave. Did you look at that?

MR. WEBER: Yes.

MEMBER BLEY: And the shock wave --

MR. WEBER: That was part of the analysis.

MEMBER BLEY: It's not just the pressure. It's the --

MR. WEBER: No, the pressure pulse dramatically exceeded the containment, you know, failure pressure, but it was such a, you know, micro seconds duration that that was not threatening, and the shock wave was also analyzed and that was part of the structural dynamic load.

MEMBER BLEY: Thank you.

MEMBER MARCH-LEUBA: If nobody else has other questions, Scott, if by any way we can oxidize the whole core and release all of the hydrogen, and then you detonate all of the hydrogen, that fails the core, the containment? I think you analyzed that one.

MR. WEBER: We did not do a structural analysis of that, so I really can't say definitively that we would fail the containment.

MEMBER MARCH-LEUBA: Okay, so you don't know.

MR. WEBER: That would need much more hydrogen and oxygen than the analysis that was done.

MEMBER MARCH-LEUBA: How long would it take to generate enough oxygen to ignite or to detonate all of the hydrogen that you could possibly produce? Are we talking three months?

MR. WEBER: Yes, so we looked at, using our conservative radiolysis production curve, we did look at the time it would take to generate enough hydrogen to reach a combustible mixture for our severe accident that produced the most hydrogen, which was actually slightly greater than 100 percent cladding oxidation due to some structural field oxidation, and we found that it was approximately 45 days until we produced enough hydrogen to reach that mixture.

MEMBER MARCH-LEUBA: Okay, so --

MR. WEBER: I think actually Jim has that in a slide, that that was going to be coming up in just a couple of slides, but --

MEMBER MARCH-LEUBA: So in summary --

MR. WEBER: -- but that would be our maximum.

MEMBER MARCH-LEUBA: In summary, we have calculations that show that the 72 hours is not a problem for containment, and it builds up to 45, and at 45 days, we are not sure whether it would or would not damage containment.

MEMBER BLEY: And I think what he said was --

(Simultaneous speaking.)

MEMBER BLEY: Well, it would have reached the flammability limit --

PARTICIPANT: Right.

MEMBER BLEY: -- which is pretty unlikely to --

PARTICIPANT: Lead to a detonation.

MEMBER BLEY: -- be a problem. I mean, you need a lot more oxygen to get to detonation level.

PARTICIPANT: Yeah, to detonation.

MEMBER BLEY: Right? That's what I heard him say was it was flammability.

(Simultaneous speaking.)

MEMBER BLEY: I think that's what I heard you say. Is that right, Scott?

MR. WEBER: Yes, what I'm trying to get across is that we know for certain that 72 hours from any combustion event, that the containment integrity will be maintained, and that we know that if we have our maximum amount of hydrogen produced, that it will be weeks of time until you would reach even a combustible mixture.

We have not looked at the specific, on containment of that maximum, nor have we looked at any point in between, and that's why we're only definitively trying to say that we have at least 72 hours until we have a detrimental mixture.

Likely if we combusted our 100 percent hydrogen production with a detonation included, I would say it's likely that there would be a threat to containment integrity, but we have not specifically done that analysis.

MEMBER BLEY: And you don't have any idea how long it would take to get to a detonation-able mixture of oxygen? That's a lot more oxygen than you'd have when you just reach the flammability limit.

MR. WEBER: Well, we would probably continue to assume a deflagration to detonation transition, so we'd just need to reach the deflagration concentrations, which we've taken generally as four percent of the lowest possible, but, no, I don't want to postulate because we haven't done a specific analysis of what that time would be when we could get to a detrimental mixture.

MEMBER BLEY: Okay, thanks. Go ahead.

MS. OSBORN: All right, so I'm now transitioning out of the timing discussion, so the next topic is operational decisions.

So, as mentioned on the previous slide, there is no less than 72 hours before a detrimental combustible mixture could be developed. It should be noted that this analysis is a bounding analysis as we've discussed, and 72 hours is consistent with NuScale's design basis passive coping period.

During this 72 hours, decisions regarding hydrogen monitoring can be evaluated, including inspecting and evaluating the hydrogen monitoring system prior to its actual use to verify the system's integrity and availability.

So, Reg Guide 1.7 provides a risk-informed decision process regarding the use of this system. It includes such factors as including the priority of these activities as compared to other post-accident activities, the necessity of the information, and additional insights gained from the specific plant conditions that might have actually occurred.

Therefore, if it is actually decided to place the hydrogen monitoring system into service, there is sufficient time to take measures to ensure its integrity and availability.

MEMBER BLEY: Well, I want to -- because I don't see any slides that get into this. One thing we had raised and we gave you a set of questions or issues we wanted to hear from, you know, when the evacuation system is normally running, those evacuation pumps are running, and you have, you know, your flow through there is probably representative of the almost nothing that's in the containment, and then if you pull a little bit of that off into the sampling system, that may be a good measure.

Under the accident conditions, the evacuation system is turned off. You would be opening it up and now you would have a fairly large, and we don't have any idea how large, evacuation system sitting there, and then you would start this little sampling pump pulling off of part of that system.

And why do you have confidence you would get a measure of hydrogen and oxygen that was representative of what's in the containment? And I didn't see anything here and I don't see you talking about this.

MS. OSBORN: Well, okay, so I do talk about it. That's the last topic, is about containment --

MEMBER BLEY: Oh, okay, I couldn't tell it from there, okay.

MS. OSBORN: But, so --

MEMBER BLEY: Well, you can wait until then if you prefer. That's good.

MS. OSBORN: Okay, that's fine.

MEMBER BLEY: As long as you have it.

MS. OSBORN: Well, and so that particular question, I don't have it particularly addressed in the slides.

So, I think it's important to understand that the normal pathway used in the containment evacuation system for during normal operations is a different flow path than is used for post-accident hydrogen monitoring.

MEMBER BLEY: Not the inlet side. The outlet side is different. The incoming side is the same.

DR. CORRADINI: What I thought Dennis is asking is you're connected to the evacuation piping.

MEMBER BLEY: Yes.

DR. CORRADINI: That's the inlet side.

MEMBER BLEY: That's the inlet side, but you don't have the outlet side open anymore. Well, they have a return path that they use under sampling.

MS. OSBORN: So what I'm saying is the part of the containment evacuation system that has the, I don't know what they call it, the pump, right, the hogging pump that is pulling the suction off containment, part of that system is not in use for --

MEMBER BLEY: The pumps aren't turned on, but the pipe's connected and the valve alignment is the same because you're coming off after the pump. I have to go back and look again.

MS. OSBORN: I think it's a different pathway. I don't --

MEMBER BLEY: That's what we asked, to show us the pathway. What's the valve lineup? And I don't think you're -- well, all we have is a cartoon of the system, so we don't know for sure.

MEMBER MARCH-LEUBA: Our concern, Jim, I raised it first, is that the volume of the -- that once you open the isolation valves and you dam containment environment into the CES, from then on, you sample what's in the CES. Now, what we're asking is what is the flow rate that goes from CES to the sampling system in the PAS --

MS. OSBORN: Yes.

MEMBER MARCH-LEUBA: -- compared to the volume of the CES? And my gut feeling is five hours' worth of volume, but if you tell me it's only two minutes, then I will be happy with that.

MS. OSBORN: Okay, so, yeah, so I can't answer the specifics of that question because those details of the system have not been designed.

MEMBER MARCH-LEUBA: They're critical.

MS. OSBORN: What I'm saying --

MEMBER MARCH-LEUBA: This includes your parameter.

MS. OSBORN: Well, what I'm saying is --

CHAIR KIRCHNER: We know going in, it's a four-inch pipe.

MS. OSBORN: True.

CHAIR KIRCHNER: That's a big opening in containment bypass space.

MEMBER MARCH-LEUBA: On the PAS, it's not on the top of the containment.

(Simultaneous speaking.)

CHAIR KIRCHNER: And then as Dennis is asking, you know, how much volume? How much pipe run before you start sampling, and then how much throughput do you have, and how representative of that, how representative --

MS. OSBORN: Okay.

CHAIR KIRCHNER: -- is that of what's in the containment?

MS. OSBORN: I understand. So, all right, I'll get to a slide and we'll talk about this. I'm just saying that the particular pathway used for the two scenarios are different, and parts of the system, of the CES will be isolated --

CHAIR KIRCHNER: Understood.

MS. OSBORN: -- such that volume does not come into play in post-accident space.

MEMBER BLEY: We'd sure like to see a sketch of that because the picture of the system that we have doesn't show a way to do that.

MS. OSBORN: Right, and what you see in

the FSAR for this flow path doesn't picture the rest of the system because it does not come into play.

DR. CORRADINI: But I guess, let me make sure we're clear. Those details that Dr. Bley and Dr. March-Leuba are asking don't exist?

MS. OSBORN: That's correct.

DR. CORRADINI: Okay.

MS. OSBORN: Pipe routing has not been done.

MEMBER MARCH-LEUBA: But if that is correct, then I have absolutely no confidence that your PAS system is sampling the containment.

MS. OSBORN: And we will discuss that.

MEMBER MARCH-LEUBA: Well, please do.

MS. OSBORN: Like I said, that's my last slide. I saved the best for last, I guess.

MEMBER MARCH-LEUBA: Tell me you're sampling it and that you have confidence that you're sampling the containment because I have some tech spec, I have some requirements, I have --

PARTICIPANT: Fixed volume, yeah.

MEMBER MARCH-LEUBA: Please, go ahead and show us.

MS. OSBORN: Well, let me get through the rest of this and then we'll come back to this. Okay, so that's all I had to say about the operational decisions, so the main point to take away from that is, you know, we have time to inspect the system post-accident before we would actually place it into service.

MEMBER RICCARDELLA: What do you mean by inspect the system? I mean, you're not going to send Section 11 folks out there to do ultrasonic exams obviously.

MS. OSBORN: Well, so I guess it had been postulated that, you know, this is a non-seismic system. Well, what if, you know, something failed in a seismic event, right? And so we're looking for --

PARTICIPANT: Gross.

MS. OSBORN: -- yeah, gross failures.

MEMBER MARCH-LEUBA: So basically something severe akin to the recovery phase on the boron dilution. Before an isolated containment, you will make sure that the volume you're dumping the containment into is not leaking.

MS. OSBORN: Well, I mean, that's just standard operating practice, right? I mean --

MEMBER MARCH-LEUBA: That's not what you're telling us.

MS. OSBORN: That's what?

MEMBER MARCH-LEUBA: That's not what you're telling us. You're telling us, "We will operate at 72 hours, period." That's what the CAR says.

(Simultaneous speaking.)

MS. OSBORN: No, I'm saying it's an operational decision, right, based on the risk-informed decision process provided in Reg Guide 1.7.

MEMBER MARCH-LEUBA: Okay, so have you told the staff what would you do if that volume is not available to open the isolation valves because it's leaking?

MS. OSBORN: Well, I mean, again, standard operating practice would be you would repair it, right, and that's what we're saying. Post-accident, we have time. That's why we have the 72-hour passing coping period, so, okay.

MEMBER MARCH-LEUBA: So, that's implied in your guidelines, or proposal, or design, is that you're going to dam the containment into the CES, but before doing that, you verify it's working either because it didn't fail or because you fixed it.

MS. OSBORN: Yes, so we would take measures to ensure that the system was still intact.

MEMBER MARCH-LEUBA: I can assure you that an ACRS member did not receive that message when we talked about it.

MS. OSBORN: Again --

MEMBER MARCH-LEUBA: The message we received is that at 72 hours, I will open the valve no matter what.

PARTICIPANT: No, I don't think we did.

MS. OSBORN: No, I don't --

PARTICIPANT: I don't remember that, no.

MS. OSBORN: So, that's just, I mean, that's life of the plant, right?

CHAIR KIRCHNER: But if you were in a severe accident state -- let's go back one slide. Don't go back on the slides --

MS. OSBORN: Okay.

CHAIR KIRCHNER: -- just to the thought that this is a low probability event. I think we agree with you, but now you've had the event. It might have been seismically initiated. The quality of the piping downstream of the isolation valves is class D for the CES system.

MS. OSBORN: Right.

CHAIR KIRCHNER: This is not the quality that's at the isolation valves, so it's not seismically qualified, which you pointed out.

MS. OSBORN: Right.

CHAIR KIRCHNER: I think when the staff presented some of their analysis, they assumed a leak rate, not a very large one, but that could lead to a significant dose both offsite and also to the control room.

So, I'm not sure under these conditions how you're going to do an integrity test, a Section 11 or not even that. What are you going to do, a visual inspection, and then based on a visual inspection, say it's not going to leak?

MEMBER RICCARDELLA: Section 11 has, you know, visual inspection requirements of V2-1 and V2-2 --

CHAIR KIRCHNER: Right.

MEMBER RICCARDELLA: -- and, you know, I think V2-1 is just, if it's still in place is --

MS. OSBORN: Yeah, so I don't think we're going to, at this point, dictate to a post-accident operation environment what method and means they might use to verify their system integrity. Again, this is -- again, we have to remember the framework we're in is a post, a non-design basis --

PARTICIPANT: I do, I do.

MS. OSBORN: -- severe accident of very

low probability, right, and the -- we're trying to, you know, pick out details that are just --

CHAIR KIRCHNER: We're trying to avoid you having to pick out the details by not unisolating containment. That's the point.

MEMBER RICCARDELLA: Well, but the trade off is how important --

CHAIR KIRCHNER: Yeah, how important.

MEMBER RICCARDELLA: -- is the hydrogen and oxygen information that you're going to get, and I guess you're coming to that, right?

MS. OSBORN: Well, no, I think --

PARTICIPANT: We covered it.

PARTICIPANT: It's on this slide.

MS. OSBORN: Yeah, we said that such mixtures were possible. Although unlikely, they were possible, and so --

MEMBER RICCARDELLA: Yeah, so there's a certain time between 72 hours and 45 days where you might need to know.

MS. OSBORN: You might need to know.

MEMBER RICCARDELLA: Yeah, okay.

MS. OSBORN: And so if that time comes, then we would take, the plant would take appropriate measures to ensure that the system is intact, the system is available, and if there are problems, they can take means or take measures to alleviate those problems. So, it leaks, all right, and they can --

MR. MELTON: So, this is Mike Melton with NuScale. So, Jim's pointed out the regulatory framework system for the beyond design basis event. I mean, that is the regulatory position.

We will make the best operational decision post the event as required, and we have a Reg Guide decision making process that Jim pointed out that will be considered, implemented into procedures and whatnot before this all even happens.

So, that is, you know, the regulatory position and operational decision making position going forward, so we're kind of going in circles, but that's where we're at. You know, we understand the concern, but this is our current -- this is the regulatory decision going forward.

MEMBER BLEY: You're giving the guys in the plant a system that you say they can sample the hydrogen and oxygen. We're not convinced from what we've seen so far that it will work, number one. Number two is what if it's bad? What have you given them to deal with that? If you're giving them a tool, you ought to have some hint of advice for them when they get there, again --

MR. MELTON: Yes, sir.

MEMBER BLEY: -- not a complete procedure and everything, but a good idea of what they would do if they ever get in this spot. What's that?

MR. MELTON: Well, I think our position is that the system is tested, operable, and checked before whatever unfortunate beyond design basis event happens. The decision to use that is based on, you know, the safest, most conservative decision making process we set up.

I mean, we'll be staffed -- we are staffed with professionals and safety conscious individuals. We'll make the right decisions. I have full confidence in that.

MEMBER BLEY: If the hardware is there to let them --

(Simultaneous speaking.)

MR. MELTON: The hardware is designed as the regulations require.

DR. CORRADINI: So, can I just ask a question? I want to make sure we're -- so let's say, let's just say for the moment that what you're proposing is workable, let's just say. What do you do with the information once you've measured it?

MEMBER BLEY: Yeah, that's where I was just --

DR. CORRADINI: So what? So you measure it and you find out, oh, my gosh --

MEMBER BLEY: Yes.

DR. CORRADINI: -- that it's one percent instead of the -- Scott calculates that at 72 hours, it's not detrimental, but to get it to burn with post-DDT, you needed four percent, and you got to four percent, but you measure it and you got one percent, and then you measure it at 96 hours and you got 1.5 percent. What do you do with that information?

MS. OSBORN: So I think all of this, the information would lead to inform the decision as to whether you wanted to vent containment or not.

(Simultaneous speaking.)

DR. CORRADINI: And so there is no other means by calculation procedure to do a bounding calculation. What I'm looking for, is there a bounding calculation you can do based on detrimental combustion that gives you just as much or even better information without having to vent containment early?

I'm bothered by the fact that you're opening up your evacuation line and you don't know what you're opening up to, whereas you could do a calculation. There might be a calculational way to look at an upper bound.

MS. OSBORN: Well, that's what we -- I mean, that's what we've done, right? That's what's in the FSAR is a bounding evaluation of these mixtures.

DR. CORRADINI: No, but then I'm not making myself clear.

MS. OSBORN: Okay, I'm sorry.

DR. CORRADINI: What I'm trying to get at is you've done a calculation that says at 72 hours, you have some concentration with some conservative assumption that it's not detrimental.

You could do that same calculation and move it forward in time and ask when it is detrimental and use that as your decision making point about venting rather than putting in a monitoring system that could potentially release radioactive materials of unknown concentration.

MS. OSBORN: So, but we are no different than other designs in this regard.

DR. CORRADINI: I'm not disagreeing with you.

MS. OSBORN: Okay.

MEMBER SUNSERI: Except does your vent harden like a BWR though, I mean, if you'd be releasing potentially flammable explosive stuff through there?

MS. OSBORN: So, it is not hardened.

CHAIR KIRCHNER: And it's lower quality.

MEMBER BLEY: It's the evacuation system, I assume.

CHAIR KIRCHNER: It's the evacuation system, so if you open it and you had the detonation in the system, then what confidence do you have that the system can withstand that event? Probably not very high confidence.

MS. OSBORN: So, I have a slide on that, too.

CHAIR KIRCHNER: All right.

MS. OSBORN: So, yes, we do have confidence.

MEMBER BLEY: Well, that's wait for that one then.

CHAIR KIRCHNER: Well, then we'll --

MS. OSBORN: Okay.

CHAIR KIRCHNER: We'd like to see that.

MS. OSBORN: All right.

MEMBER RICCARDELLA: You know, Mike, the other issue, I mean, suppose they do monitor it and instead of 1.5 percent they find it's four percent?

That's going to tell them to do something, right?

DR. CORRADINI: But what they choose to do wouldn't change by essentially an early monitoring. What they choose to do --

MEMBER MARCH-LEUBA: Do you have a mic?

DR. CORRADINI: I'm sorry, excuse me. Unless I misunderstood, what they choose to do is not going to -- it's a timing decision, but you choose to do would be the same result.

So, I could do a calculation and not do an early opening of the system, and have an upper bound as to what the concentration is. They did it at 72 hours. They can do it at subsequent times. That would create the shortest time to a worry without having to open the system, unisolate the system. That's all I'm getting at.

MEMBER RICCARDELLA: Well, but, you know, we're using the term unisolate. I mean, even if it's not a class one seismic system, I'd say there's still a high probability that it's going to be intact. They're not automatically venting containment just by opening it up to that system.

MS. GRADY: Dr. Corradini, this is Anne-Marie Grady, the staff reviewer on this topic, and NuScale has already in their generic technical guidelines decided that a prudent time to consider taking mitigating action, whether it's venting or inerting the containment, is to do it when the oxygen concentration is three percent in containment.

But you'd still need to know if you were approaching that and you'd still need to open the containment for any mitigating action you're going to take, whether it's going to be venting and you have to open CES, whether it's inerting and you have to open CVCS and the nitrogen distribution system.

So, there are other points of data that would tell you that you could, like three percent, let's say, which does not support combustion, is a safe time to take action or to plan action.

DR. CORRADINI: So I think you've made a very good point, so let me counterpoint. So I can do a calculation that gives me the earliest time to reach three percent based on radiolysis and the optimum time to combustion and not monitor, but at that point, make a decision to inject nitrogen at a higher pressure, so I'm not going to leak out. I'm going to leak in, and then I don't go through the worry of having to open up containment and unisolate early, release materials when I don't necessarily need to.

MS. GRADY: But I think you would also

want to, if you took the mitigating action, if you opened up the containment and took the mitigating action, you'd want to confirm it was successful.

So, you're still going to, I think, need to use hydrogen and oxygen monitoring flow path to convince yourself of that, otherwise you'd have to do a calculation that says how much you have to inert with the nitrogen or how long you'd have to vent, and I don't think those exist right now.

DR. CORRADINI: I see your point.

MS. OSBORN: Thank you. Okay, so, moving onto the radiation protection issue, this is slide nine. So, if the decision is actually made to place the system into service, we think there is a high degree of confidence that the system's integrity will be intact.

First, the system that is used for hydrogen monitoring are included in the leakage control program. This program is one of the post-TMI action items that is intended to minimize potential leakage from systems outside containment that may contain accident source term.

Second, these systems are used during normal operations, so system integrity issues would likely be discovered and remedied during normal operations.

And third, as discussed before, the operators have sufficient time post-accident to evaluate and inspect the system prior to its use. So, the analysis of this leakage path is unprecedented among other applicants, and if they were required, could lead to some compliance issues.

If the staff thinks this is a safety issue, the generic implications should also be considered, but if it is hypothesized that the hydrogen monitoring system leaks excessively, subsequent actions could be to isolate the leak.

This would be an unplanned, ad hoc operator action which would be the responsibility of the emergency response organization as an unanticipated emergency action and would fall under 10 CFR 50.47(b)(11) which is the responsibility of the emergency plan and the emergency response organization.

But the staff's position, as they have stated, is that there is not enough design information to perform these dose analyses and the so-called carve out of the rule will allow this to be resolved in the future.

MEMBER MARCH-LEUBA: Jim?

MS. OSBORN: Yes?

MEMBER MARCH-LEUBA: I have a favor to ask.

MS. OSBORN: Yes, sir?

MEMBER MARCH-LEUBA: You just placed in the record all of this document. You just read it and we will have a transcript of it two weeks from now. Is there a way that you can give that to Mike so we can read it because you talk very fast?

MS. OSBORN: Oh, do I?

MEMBER MARCH-LEUBA: We're going to have to discuss it for the letter. I would love to have that document. I mean, you just placed it on the record by reading it. Can you give us a copy?

MS. OSBORN: I don't know.

MEMBER MARCH-LEUBA: Can you talk slower and do it again?

MS. OSBORN: I can definitely talk slower.

MEMBER MARCH-LEUBA: I think you can do it. You placed it on the record.

MS. OSBORN: Yes, sir, so would you like me to go through this slide again?

MEMBER MARCH-LEUBA: I'm just kidding, but it would be nice if we could read it because we're going to have to argue among ourselves when we write our letter about this whether we agree with you or not.

MS. OSBORN: Yes, sir.

MEMBER MARCH-LEUBA: It would be nice to have it in front of us what it is that we are agreeing on.

MR. PRESSON: Yeah, I'll check with Mike and see what that process would be, so.

MEMBER MARCH-LEUBA: The process for that is we have to wait for the court reporter to do the transcript and then we can read it, but that's going to take a week. I'm just putting it out there.

MS. OSBORN: I'm sorry I was talking too fast.

MEMBER SUNSERI: We can expedite that transcript. We can get the transcript.

MEMBER MARCH-LEUBA: Yeah, yeah, but we're going to write the letter Thursday.

MEMBER BLEY: Expedited, it's a week to two weeks, maybe four days once in a while, but it depends on their load offsite, so it's not immediate.

MEMBER DIMITRIJEVIC: Well, I was bringing this before because everybody comes with the reading slides, and it would be very useful to have actually reading slides, not the seeing slides.

So, I don't see what is the issue of issuing reading slides which they will show in the transcript anyway, so, I mean, I don't understand what is the problem.

CHAIR KIRCHNER: It's just the time to get the transcript. That's all.

MEMBER DIMITRIJEVIC: No, but why cannot we just have reading slides as a part of the meeting?

CHAIR KIRCHNER: That's up to NuScale. That's a personal or corporate decision.

MEMBER REMPE: Why don't you go through the slide again?

MS. OSBORN: I can, and I will go a little bit more slowly this time.

MEMBER RICCARDELLA: He might have some uncomplimentary things about ACRS in his notes.

MS. OSBORN: No, I can assure you.

MR. OSBORN: Okay, so I will do this again, all right, and I will try to slower. So if the decision is actually made to place the system into service, we think we have a high degree of confidence of the system's integrity and that it will be intact. So, and there are three reasons for that. One, first it listed there is we've included this system as one of the systems in the leakage control program.

So leakage control program is one of the post-TMI action items to address this very issue. So it's intended to minimize the potential leakage from systems outside containment that might contain accident source term. So obviously this is a COLA item. We don't have the program written today. But that's, this system and this pathways go into that leakage control program.

The second reason we think it's, will be of, the system will be intact is that we use this during normal operations. And so any systems integrity, system issues would be discovered and remedied during normal operations.

And then third, as we discussed before, the operators have time post-accident to evaluate the system, inspect the system, and ensure that it's intact and that the system is, has integrity.

So the analysis of presuming a leak path, right, from the hydrogen monitoring system, is unprecedented in other applications. And we think that if that was required of other applications, that they also might have dose criteria compliance issues. And so, but that hasn't been looked at in other designs.

MEMBER MARCH-LEUBA: Yeah, but in most

applications, you put the hydrogen monitoring inside containment and nothing leaks.

MR. OSBORN: No, sir, not always.

MEMBER MARCH-LEUBA: Not always, but --

MR. OSBORN: So a case in point, as I pointed out before, is Watts Bar II. They have a hydrogen monitoring system outside containment that non-safety. And so this is not unprecedented from a design standpoint. And so NuScale we don't think is unique in that regard.

So we just think that if this is a safety issue concern, that the generic implications of this ought to be looked at as well. It's not unique to NuScale.

DR. CORRADINI: So I don't want to interrupt you, but I wanted to get to your last bullet. So if you do a carve-out, does that mean you can come back later and ask for an exemption?

MR. OSBORN: That would be up to the COLA applicant, right.

DR. CORRADINI: Because now back to unique features. You have a, I think is allowed to say on public, you have 1050 psi containment.

MR. OSBORN: Yes, sir.

DR. CORRADINI: That makes it unique that you inert and stay under a combustion mixture of any sort and then sample it, rather than taking the chance of any sort of sampling and having a combustion.

So there is unique features on how your containment is strong enough that you could actually take calculated estimates of an upper bound of concentrations that are combustible, inert it so it's not combustible, and then do the sampling. And that would require an exemption, because it's not doing monitoring after 72 hours. But to me, from the way your containment, the way your system is designed makes it a lot more advantageous --

MR. OSBORN: So there may be more flexibility on the mitigation side.

DR. CORRADINI: Yeah.

MR. OSBORN: Right? So when you say sampling, so you inert it and then sample, what's the difference between sampling and monitoring in your mind?

DR. CORRADINI: Because now I have no chance of combustion.

MR. OSBORN: Right.

DR. CORRADINI: Once I start sampling, I'm taking out a mixture that can't combust. I don't have to worry about a hardened vent, I don't have to worry about venting combustion. I basically take a sample, which will take time, but I have it mixed with nitrogen, so I can't, I don't have to worry about it being combusted, combustible.

MEMBER MARCH-LEUBA: No, if you pacify the containment so it cannot detonate, you don't need to sample it.

DR. CORRADINI: Eventually you're going to have to know what's there, because now I have this, I'm in this residual risk zone of assuming a severe accident, and I will understand its situation going forward in perpetuity.

MEMBER PETTI: But the decisionmaking process is completely different at that point than if you hadn't inerted.

DR. CORRADINI: Right.

MEMBER PETTI: Because you have to worry about the risk of detonation.

CHAIR KIRCHNER: The detonation could come with the unisolating --

DR. SCHULTZ: Correct.

CHAIR KIRCHNER: Of the containment.

MR. OSBORN: Again, these are going to be --

CHAIR KIRCHNER: That's the worst possible way to do it.

DR. CORRADINI: But the reason I started off with the bullet --

CHAIR KIRCHNER: Because containment is designed for --

DR. CORRADINI: Is if that if the COL applicants seize an advantageous way of doing this, they can ask for an exemption and a different path forward in terms of how they do the mitigation, assuming a severe accident. How do they do the monitoring? During a severe accident, excuse me.

MR. OSBORN: So yeah, obviously the COL application has lots of options, right. And we wouldn't presume to impose what those options may or may not be, if I understand your question right. Operationally, those kinds of choices of what do I do in mitigation space, those kinds of -- that's what emergency response organizations are for. And so post-72 hours, this is, you know, in SAMG space, as we say, severe accident mitigation guidelines.

MEMBER SUNSERI: I just want to push back on your statement about hydrogen monitors being external, a generic issue. We don't disagree that there are plants that have external hydrogen monitoring systems. But that's exactly what they are, systems designed specifically for monitoring hydrogen, all equipped, all the engineering worked out. Not a you know, what I'll can --

CHAIR KIRCHNER: An appendage.

MEMBER SUNSERI: Appendage, yeah. You know, this, it started out with a four-inch line. I mean, nobody has sampling system that has a four-inch line as its starting point.

CHAIR KIRCHNER: No one would design a sampling system with a four-inch line. It's like you not to second-guess your design, but it's like an appendage that's put on an existing system just to minimize the penetration for containment. But boy, a four-inch line to do a sample?

MR. OSBORN: So I understand the negative perspective that you bring to that. The positive aspect of that same perspective is that the system is used normally. So a dedicated hydrogen sampling system is not used normally, right.

So to me, the systems that leak more often are the systems that are not used versus the systems that are routinely used. And so I think the fact that we used a system that was in normal operation for a different purpose for post-accident purposes has its advantages as well.

Okay, so where was I? All right, so we talked about the generic implications. But if, so what I was going to say, if the, we hypothesized that the hydrogen system leaks excessively. Again, this will be emergency response organization type of action to ameliorate that leak.

So, but that would be an unplanned, ad hoc, operator action, which would be the responsibility of the emergency response organization. And it's an unanticipated emergency action would fall under the emergency plan rules and guided by the emergency response organization, so.

But the staff's position is that there's not enough design information to perform these specific dose analyses, either off-site or operator dose. And so the carve-out would allow this to be resolved in the future. All right?

MEMBER MARCH-LEUBA: My main concern obviously is an isolated containment and dumping all the isotopes out there. But after your presentation, I still don't know if the PAMS will work for the concerns that we're talking about.

MR. OSBORN: Okay, I --

MEMBER MARCH-LEUBA: This is probably a question for the staff, but I think my philosophy will be before I certify this design, I have to know that there is at least one instance of this pipe running that will work. I mean, it's upon you to say I don't know where the PAM system going to be mounted on my third plan installation. They'll have to look at it. But I could run it this way, and it will work. And I don't think you've done that.

MR. OSBORN: Okay, I've got a slide on that, and like I said, I think that's my last slide, so we will get to that.

So now I'm on the slide having to do with equipment capability, slide 10. So this is, again, regarding this committee's statement related SSCs being able to withstand a hydrogen combustion event. So it is correct that containment is designed to be able withstand without loss of structural integrity, any hydrogen combustion event for the first 72 hours. However, it is also true that the hydrogen monitoring path, pressure boundaries, can also withstand such a hydrogen combustion event in containment.

In fact, the design capability's already included in FSAR table 3.2-1, and it states, quote, Pressure boundary components of any monitoring path outside of containment shall be designed to withstand combustion events corresponding to the capability of containment.

So therefore the same claim regarding the ability to withstand a combustion event for containment can be made for the hydrogen monitoring system pressure boundaries. NuScale and the NRC staff agree that this design capability has been accounted for.

CHAIR KIRCHNER: So the design pressure of the containment evacuation system is 1050 psi?

MR. OSBORN: No, sir.

CHAIR KIRCHNER: Okay, so -- the isolation valve, I know, I understand that. Okay, so then the table says that it should be designed for that. What is the design spec for the CES system that you can demonstrate that it can withstand such a ---

(Simultaneous speaking.)

MR. OSBORN: So this analysis of to take a combustion event inside containment and propagate it through lines outside of containment has not been done, and it cannot be done until pipe is routed, system is fully designed. But that --

CHAIR KIRCHNER: That's part of our concern. So you're saying that --

MR. OSBORN: But the requirement's there --

CHAIR KIRCHNER: Table 3.2 will require them essentially -- see, one of our concerns was that if you un-isolated, the detonation could happen at that point. The valves could trigger the, be the energy source for setting off the event. So you're saying that 3.2-1 will require the COLA, the COL applicant to design that system to withstand one of these pressure pulses.

MR. OSBORN: That's correct.

CHAIR KIRCHNER: That wasn't obvious.

MR. OSBORN: No.

CHAIR KIRCHNER: But maybe I need to review 3.2-1 again. That was certainly one of our concerns.

MR. OSBORN: Yes.

CHAIR KIRCHNER: Okay.

MR. OSBORN: Yes, and that's why I wanted to address that. That we have accounted for that, you know, possibility that, or that design requirement that we designed the pressure boundary of any monitoring path outside containment to withstand a combustion event inside containment. All right?

Now to the last slide, containment mixing --

MEMBER MARCH-LEUBA: Which I've had time

to read it, that's not addressing my question.

MR. OSBORN: Well, okay, so let talk through it and see if we can get there. So containment, mixing, and sampling, this is another issue raised by this body regarding hydrogen monitoring and being able to obtain representative monitoring. First of all, ANSI N13.1, to which NuScale has committed, requires the sampling of this type be representative.

Second, representative sampling is dependent upon drawing upon a mixed, a well-mixed fluid. So regulations require that post-accident containment atmospheres be well mixed. So that representative sampling can occur, and it prevents pockets of combustible mixtures being developed earlier than expected.

The containment mixing is described in FSAR 6.2.5 and was further explained in the response to RAI 8862. And NuScale has demonstrated that the containment is well mixed, neglecting any mixing contributions from, induced by ECCS flows through containment.

This mixing inside containment is driven by the delta T between the reactor pressure vessel wall and the containment vessel wall. And this delta

T is driven by the core's decay heat against the cooler environment outside of containment, which is a condition that will persist longterm.

So NuScale and the NRC staff are in agreement that NuScale is in compliance with the regulations regarding mixing and representative sampling. The quote on this slide is from the NRC safety evaluation report regarding this compliance.

DR. CORRADINI: But I don't mean to interrupt, but what Dr. March-Leuba's asking for is the, I'll call it timing, from the time you decide to open the isolation valve to the time you're actually going to take a representative sample that represents containment.

MR. OSBORN: So it's a flushing time, right?

DR. CORRADINI: Right.

MR. OSBORN: Yes.

DR. CORRADINI: So are you committing to a flushing time?

MR. OSBORN: We don't know that time, because --

DR. CORRADINI: Well, reverse the problem. Are you committing to a design limit that it shall not be greater than X? That X will not be, that you pick a time and by your design, it will not be longer than an hour, two hours, whatever? That's what I thought you were, he's asking.

MEMBER MARCH-LEUBA: That's exactly -- I'm telling you your flushing time is 100 hours. Prove me wrong.

CHAIR KIRCHNER: This Chapter 6, wait a minute. Yeah, before we even get there, let's get to the source that you're going to draw. The containment extraction system takes suction from the top of the containment essentially, right?

PARTICIPANT: Yes.

CHAIR KIRCHNER: This quote is during the blowdown phase and such. Our concern isn't during this time period, this part from Chapter 6, well mixing. This had to do with condensation and other effects during the cooldown period. Let's assume you've cooled and melted the -- not melted, but you've got a zirc oxide reaction, whether there's melting or not.

So you've got a hydrogen source. The hydrogen is going to migrate to the top of the containment, and that mixing may continue well below the hydrogen level, but that's not what you're taking out. You're going to take out hydrogen first.

This mixing is the steam mixing during the blowdown phase when the RRV -- the RVVs or the RRV, the ECCS system goes into play. But we're out now 72 hours or so. And yes, there will be buoyance and turbulence probably inside that containment. But the hydrogen's going to go right up to the top. You're going to pull off hydrogen first.

MR. OSBORN: So I think this part of the FSAR that the SER is referring to has to do with this whole issue of combustion --

CHAIR KIRCHNER: Even way out at -- because we're now 72 hours or more, and now you're going to consider ---

(Simultaneous speaking.)

MR. OSBORN: No, this is for the first 72 hours.

CHAIR KIRCHNER: All right, or let's just say we're at 72 hours.

MR. OSBORN: Right.

CHAIR KIRCHNER: If you've produced hydrogen, the hydrogen will separate from the steam.

MR. OSBORN: Not in a turbulent environment.

CHAIR KIRCHNER: It's not clear how turbulent it will be at that point.

DR. CORRADINI: Once I mix, I don't unmix. I'll have a different concentration because of condensation. That's what I thought you were getting at.

CHAIR KIRCHNER: Yeah, well, the condensation's going to make this more quiescent than turbulent over time. So now we're out there at a significant point in time, the ECCS system has done its job.

MR. OSBORN: But it continues.

CHAIR KIRCHNER: Static --

MR. OSBORN: I know, I know.

CHAIR KIRCHNER: There's heat, yeah, there's going to be circulation. But my sense is because of the condensation and other effects, you're going to get separation. You're not going to get a very representative mixture, not initially. And then it depends how much volume is outside containment in the CES system before you get to your tap where you actually do the sample.

MR. OSBORN: Which would tend to increase the hydrogen, apparent hydrogen concentration?

MEMBER MARCH-LEUBA: Yeah, but we are worried about --

CHAIR KIRCHNER: But it's not

representative anymore.

MEMBER PETTI: It's really why we're worried about the oxygen. You need to get, and the oxygen --

CHAIR KIRCHNER: Yeah, it's the oxygen.

MEMBER PETTI: And it won't be in the top, it'll be down in the bottom, and you may -- so you'll get a false measurement is what --

MEMBER MARCH-LEUBA: There are two issues. Is the containment mixed or not, that's what Walt is saying. I don't think it is, but let's give you that the containment is well mixed because you have sufficient turbulence, and it was tall and narrow, hard to believe there's going to be that much turbulence.

But then when you dump that containment volume into the four-inch pipe, which as far as I know it could be a hundred foot long, maybe more, but I don't know, you tell me how long it is.

MR. OSBORN: Yeah, so there is a dedicated system for each module, right. So it's not like there's a long run of pipes.

MEMBER MARCH-LEUBA: Dr. Corradini was saying tell me what the ratio is between the mass flow rate in the PAMS pump that is something for there and what the volume is and specify a maximum time delay for this flushing. Because as I tell you, it's 1000 hours. I'm as right as you are because none of us know what the answer is.

So there should be a specification on the, on your design that says the flushing time for this system cannot be greater than, and you tell me what the number is, two hours, ten hours. And then I'm happy, at least that part works. You still have to worry about all the stratification and where the oxygen goes and where the hydrogen goes.

MR. OSBORN: So I'm not an expert on ANSI N13.1 having to do with sampling and monitoring. I don't know if there's a maximum flushing period as part of that ANSI standard or not. I do know the ANSI standard requires us to perform representative monitoring or representative sampling.

MEMBER MARCH-LEUBA: Well, the design you're showing me on the drawing does not do it because it has a time delay for flushing. I mean, the design that you're showing me does not satisfy ANSI N13.1-2011. Prove me wrong.

MR. OSBORN: Well, I can't because the system hasn't been designed in detail to figure out all the details you're referring.

MEMBER MARCH-LEUBA: So if you're not willing to solve the problem now, at least specify what your bounding parameters will be for the design in the COL. You'll say okay, the COL can do whatever routing of pipes they want to do as long as it's represented within a two-hour time constant.

MR. PRESSON: Well, and that's part of our FSAR commitment to the ANSI standard for having that representative sampling. That's written into the FSAR. So as we --

MEMBER MARCH-LEUBA: What is written?

MR. PRESSON: Commitment to N13.1.

MEMBER MARCH-LEUBA: Yeah.

MR. PRESSON: So as we finalize, well, as the COL finalizes that design.

MEMBER MARCH-LEUBA: If you have a 100 foot four-inch pipe, and you have an aquarium pump something for it, it might take 100 hours.

MR. PRESSON: And then it's no longer representative, and so you have to go back make sure you meet the FASR.

MEMBER MARCH-LEUBA: You or the staff needs to define what representative means. I see a hole here.

MR. PRESSON: Understood, yeah.

MEMBER MARCH-LEUBA: If you're 100 hours behind containment, that's not representative, but you will agree on that.

MR. PRESSON: Yeah.

MEMBER MARCH-LEUBA: If you're 14 hours, eh, maybe it's okay, maybe it's okay, maybe it's not. Do we need two hours, what do we need? You need to agree on that before you design it.

MEMBER PETTI: Well, the question is whether the ANSI standard has some of that in there.

MEMBER MARCH-LEUBA: I don't know.

MEMBER PETTI: I mean, I would just be shocked. I mean, anybody who does sampling knows you've got to flush, you know, you got to get an answer in a reasonable amount of time, which means you have to design it. So it's probably worth trying to say what that standard says I'd be surprised.

MEMBER MARCH-LEUBA: How can we make a decision if we don't know?

MEMBER REMPE: We actually have access to the standards.

CHAIR KIRCHNER: Yeah, we can pull up the standards.

MEMBER DIMITRIJEVIC: But I would like to make from my risk prospectus how we see, because everybody has so far discussed that you, how efficient or unefficient or useful or not useful the system. And comes to the risk-informed decision, this is what is currently happening.

And I want to tell you why I think that this is not every case which you say exists in the industry. Because the first time when we start thinking about this issue as, you know, purely analyst, I said well, wait a second, everybody has this system, why is this not looked before.

The main reason is the coping time here is 72 hours. So nobody in the current industry is dealing with anything longer than 24 hours. The second thing is the here we saw this in the Asian issue which question habitability of main control room, which is not, you know, doesn't exist in other case. And you have a very specific containment when you try to minimize number of the penetrations and you have a large line coming on this.

When it comes to the risk prospectus, once when you open this, this is it, you're getting large release how currently model of the PRA setup. They never really question what type of the, you know, the fission --- releases are going to happen in 72 hours. But the assumption is if containment isolation fails in 72 hours, you directly lead to large release.

This containment can only fail if it's bypassed, either by failure of containment isolation or by, you know, steam generator tube rupture or by LOCA outside of containment. So currently, if the operator is going to bypass containment isolation and un-isolate that within 72 hours, we go directly to large release.

Therefore, they can either make argument that large release is not likely to happen in 72 hours, they could, I assume. And they, but they have to change how the model is currently the PRA. So what Michael is going to say, if this is really has a potential to, you know, question habitability of main control room leads to releases, and it's not doing any useful function from risk-informed point of view, do you really need this. So that's a main argument.

If this has to become part of containment isolation discussion in the PRA if we conclude that this is going to be done within 72 hours, okay, the currently it's not.

DR. CORRADINI: So I want to summarize what you just said. Your point is that this action is not in the PRA.

MEMBER DIMITRIJEVIC: This action is not

in the PRA, it's not part of containment isolation function analysis.

DR. CORRADINI: So Scott Weber's on the line. I thought he was somehow connected to the PRA. Is that correct, that it's not part of the PRA?

MEMBER DIMITRIJEVIC: There is no discussion of this system --

MR. WEBER: Yes, I can confirm that un-isolated containment for the purpose of hydrogen monitoring is not currently considered in the PRA.

DR. CORRADINI: Thank you.

MS. NORRIS: This is Rebecca Norris with NuScale. Scott, sorry, this is going back a couple topics, but we got a little bit more of a thorough answer on the mixing RAI question, so Scott, do you want to go ahead and talk about that?

MR. WEBER: Yeah, I just wanted to quickly follow up on the conversation that was being had before about whether or not the mixing, the argument that is being presented on this slide is about the steam blowdown period and whether gasses would still remain stratified in the upper CNV.

And I pulled up the associated RAI and the, that analysis was done all the way out to 72 hours. It demonstrated well mixing through the entire duration, so that's well beyond the initial blowdown period. It would also sort of contain the sort of longterm natural, or decay heat driven natural circulation.

It also did include combustible gasses in that analysis, and it did demonstrate that they would be entrained by the, what they call a buoyant steam jet that flows into the upper CNV and then down the exterior inside surface of the CNV. So that analysis did demonstrate that all the way through 72 hours, including consideration and combustible gasses, that the containment atmosphere was well mixed. So I just wanted to make sure that that was clarified.

MR. OSBORN: Thank you, Scott. So, I did have, I lied, I have one more slide, which is just a summary and conclusions.

So I just want to kind of recap where we've been here. So we first discussed the overall paradigm of accident analysis as it relates to the differences between design basis and beyond design basis, and the rules that we as an industry apply related to accident mitigation and using non-safety related systems for that mitigation.

We've also expressed in the past that given the low frequency of a NuScale core melt accident, it seems to be in the realm of the incredible. And it's hard to see how it can be even considered credible.

Second, we discussed the timing aspects of combustible gasses inside containment, and that we have performed a bounding analysis that shows that there is a minimum of 72 hours before a detrimental combustible gas mixture could form inside containment.

And third, we discussed the risk-informed decision process in which operators would utilize in actually placing this hydrogen monitoring system into service. And we discussed that there's sufficient time to allow operators to inspect and verify that the system is intact and available.

And regarding radiation protection, the staff has stated that there is insufficient design information to perform either an offsite or an operator dose from a leaky monitoring system. Therefore, a carve-out, created a carve-out for the rule so that this issue could be resolved at a future date.

Then we discussed the hydrogen monitoring --

DR. CORRADINI: Well, just --

MR. OSBORN: Sorry.

DR. CORRADINI: This is more for my education, but what's the difference between a carve-out and a COL item?

MR. OSBORN: So a COL item I believe is something we create as part of the DCA.

DR. CORRADINI: And the carve-out is something they -- the staff creates.

MR. OSBORN: And so the carve-out is more like a COLA item that the staff creates.

DR. CORRADINI: But is it treated identically the same? It's essentially the owner/operator's going to have to show compliance with the equivalent of a staff-related COL item?

MR. OSBORN: Yes, from my understanding that is, from that perspective they are similar.

MEMBER MARCH-LEUBA: And would the difference be a COL item is something we have an agreement on how it's going to be resolved, you just need to do the calculation. Whereas a carve-out, we don't have an agreement on how it's going to be resolved, and that's why it gets postponed?

MR. OSBORN: I don't know that you make that generalization.

CHAIR KIRCHNER: I think the staff will address that.

MR. TESFAYE: This is Getachew Tesfaye. Chapter 9, a Project Manager, carve-out essentially says that the staff has not reached any conclusion on the design of that, this particular design. In other words, we're not making it a finality of the design at this stage.

COL item, on the other hand, is the staff reviewed the COL item and makes the determination this is an appropriate COL item for the applicant to, for the COL applicant to handle. So a carve-out is just completely eliminates this portion of the design is not certified.

DR. CORRADINI: So it's an open item going to the COL.

MR. TESFAYE: Yes, it's, we have not made any determination on this particular aspect like the design because we didn't have any information.

MS. GRADY: Not with respect to monitoring, with respect to leakage from the monitoring path. That's the carve-out, it's that narrow.

MEMBER REMPE: So in a way it's a bit easier because they don't have to do an exemption, or it's a different approach. They don't do an exemption, it's not been decided, right? Because earlier we asked, or Mike asked about this, can they get an exemption.

MS. GRADY: Finding on the leakage from the path. There is a finding --

MR. TESFAYE: Yeah, so I was just going to make some point here. A carve-out was needed because Applicant did not want to submit an interface item in tier one. This could have been handled in a normal way if the applicant agreed to submit this as an interface item that will be tracked in tier one as a COL item.

The applicant did not want to have this in the tier one as an interface item, so the staff was forced to carve this out of the regulation. So it's the only we thing we can do to move forward.

CHAIR KIRCHNER: Why don't you wrap up here, and then we're going to take a break, and then we'll get the staff up and we can --

MR. OSBORN: Okay.

CHAIR KIRCHNER: See their, hear their position.

MR. OSBORN: All right, so I'm just finishing this slide. So we discussed the hydrogen monitoring pathway and the fact that it will be capable of withstanding a combustion event, just like containment can. And NuScale and the staff agree that the system will be, is accounted for, will be able to withstand such an event.

And the lastly we talked about containment mixing and ensuring representative monitoring, and NuScale and the staff agreed that this has been adequately accounted for, so.

MEMBER BLEY: Jim?

MR. OSBORN: Yes, sir.

MEMBER BLEY: Just a clarification. The ability of a CES to withstand the hydrogen burn event is at 72 hours, is that correct? Or any hydrogen burn event.

MR. OSBORN: So as the, as table 3.2-1 says, it says, as well as containment can, right. So at 72 hours, yes, the monitoring pathway would be able to withstand any combustion event like containment. There is a, there --

CHAIR KIRCHNER: Let him finish.

MR. OSBORN: So yes, the answer to your question is yes. Now, we haven't analyzed, as Scott Weber said, we have not analyzed after 72 hours what might happen.

MEMBER BLEY: So if I've bought one of these and I'm operating it, when I get to 72 hours, I know I'm okay if I open it up and sample and filter and vent it if I need to. But if I decide to wait a while, I'm no longer guaranteed that that's the case should a burn happen later on, before I decided to open it up to sampling.

MR. OSBORN: Just as in containment you wouldn't know for sure either.

MEMBER BLEY: Right.

MEMBER RICCARDELLA: I was just going to say I've got the table up if you wanted me to read the statement. Okay.

CHAIR KIRCHNER: Thank you, Jim.

MR. OSBORN: All right, thank you.

CHAIR KIRCHNER: No good deed goes unpunished, so --

MR. OSBORN: I've heard.

CHAIR KIRCHNER: With that, let's take a break until five after -- better make that ten after 11:00. And then we'll have the staff. And I apologize in advance to the staff, we've used more time than we had expected. We are in recess.

(Whereupon, the above-entitled matter went off the record at 10:53 a.m. and resumed at 11:10 a.m.)

CHAIR KIRCHNER: Okay, we are back in

session. We are now going to turn to the staff to hear on Chapter 9 and related topics. So Getachew, are you going to make the start-off?

MR. TESFAYE: Yes.

CHAIR KIRCHNER: Please go ahead.

MR. TESFAYE: Thank you, Chairman. Good morning, everyone, my name is Getachew Tesfaye, I'm the NRC project manager for NuScale design certification application Chapter 9, auxiliary assistance in the accident source term methodology topical report.

As you can see on this list, several members of the NRC staff contributed to the Chapter 9 review and the accident source term topical report. Key staff members are here in the audience to support this briefing. On December 10, 2019, the staff issued the phase 4 Chapter 9 SER evaluation with no open items for ACRS review.

As the Committee pointed out correctly, the phase 4 and phase 2 SER differ in several areas as a result of a new approach the staff adopted by evaluating information on the docket rather than discussing the individual open items and their resolution. As you'll see in our presentation today, all the SER changes in phase 4 of the SER are the result of information submitted to close open items or changes made in other chapters.

None of these changes involve a design change to the systems and components evaluated in phase 2.

Our other presentation today addresses questions raised by ACRS regarding our presentation to the full Committee in December 2019 on accident source term methodology and areas of focus. The specifically issues involving post-accident hydrogen oxygen monitoring systems and the process sampling system.

We'll start off our presentation with the post-accident hydrogen oxygen monitoring and process sampling system. Anne-Marie Grady and Ed Stutzcage will make that presentation, and then Raoul Hernandez and Chang Li will address the major areas of change in Chapter 9 phase 4 SER, and I'll close out the presentation by discussing the remaining open items in Chapter 9.

With that, Anne-Marie.

MEMBER BLEY: May I ask something now because it --

MR. TESFAYE: Did I say something?

MEMBER BLEY: No, you, well, you did a few minutes ago, and so did Anne-Marie. I think I heard you say, and I think that's what I remember reading, that the mixing issue we've talked about is not anything you've challenged, but --

MS. GRADY: For 72 hours.

MEMBER BLEY: Yeah, for 72 hours. But my question has to do with ANSI N13.1-2011 and the associated regulation, 10 CFR 5044(C)(1) that was discussed by them. You folks, I assume, would have looked at those. And are you of the opinion that meeting the requirements in the regulation and the ANSI standard will require the COL applicant to ensure that they're getting a representative sample at the time they do sample?

MR. TESFAYE: I have a slide on ANSI --

MEMBER BLEY: If you're covering it already, that's fine.

MR. TESFAYE: Yeah, it's in there.

MEMBER BLEY: But since we hadn't asked that, that's why.

MS. GRADY: No, Dr. Bley, you're asking a very specific question. First of all, the technical reviewer who evaluated the mixing was Boyce Travis, and he's not here at the moment.

MEMBER BLEY: Okay.

MS. GRADY: He evaluated it for 72 hours, as I just said. I have not, so I can't answer your question directly, but I'll try to get an answer for you by the end.

MEMBER BLEY: That's fine.

MS. GRADY: Do you want to know if he considered it? Because I certainly haven't.

MEMBER BLEY: Sure, yes.

MS. GRADY: ANSI standards?

MEMBER BLEY: Yeah.

MS. GRADY: I will find out from Boyce by the end of the day.

MEMBER BLEY: And if he thinks that requires them to make sure that they do have a representative sample when they open up the PSS.

MS. GRADY: But you're not I'm talking about a specified flushing time, you're just talking about representative sample.

MEMBER BLEY: Well, that's kind of embedded.

MS. GRADY: Uh huh.

MEMBER MARCH-LEUBA: Yeah, so both, is the containment mix, and what is the flushing time on the four-inch pipe.

MS. GRADY: Boyce made a finding in the SE that it was mixed. He agreed with NuScale that it was mixed in the first 72 hours.

MEMBER MARCH-LEUBA: And now the flushing or the four-inch pipe, it's a separate issue.

MS. GRADY: I don't know that he looked at that. I will talk to him and get back to you by the end of the day.

MEMBER REMPE: Walt, just so we all kind of understand the game plan, we were supposed to have a meeting that some of us, including yourself, is supposed to, and Matt and me, are supposed to attend at noon, and perhaps some other members. Are we going to hold to that firm schedule and take a break if we don't finish? Because we have --

CHAIR KIRCHNER: I think we'll have to take a break if we don't finish and ask the staff to come back after lunch.

MEMBER REMPE: Okay, I just kind of wanted to make sure. And if some of the staff members that's a problem, it's a good time to let us know. And the meeting goes from 12 to one and we apologize.

PARTICIPANT: Yeah, no problem.

CHAIR KIRCHNER: Go ahead, Anne-Marie.

MS. GRADY: The hydrogen and oxygen post-monitoring in the containment is used --

MEMBER BLEY: Anne-Marie, I don't think

your mic's turned on.

MS. GRADY: Just turned it off, thank you. The hydrogen and oxygen post-accident monitoring in the containment is used to measure the gas concentrations to identify flammable conditions early enough to prevent the deflagration to detonation transition, the DDT event. The NuScale containment integrity post severe accident following a postulated DDT event has been analyzed to be maintained for 72 hours, we're in complete agreement there.

Radiolysis, which produces both hydrogen and oxygen, continues for weeks after a severe accident and could lead to a potential DDT threat at or about 45 days. Now, at 45 days NuScale has determined that conditions for combustion would occur, five percent oxygen, at least four percent hydrogen, and there's much more than that, and establishing the conditions for combustion. They are then postulating a DDT.

There's no mechanistic analysis that goes all the way out and proves it would occur at those conditions. They're postulating it for conservatism.

Okay, the status of the review on hydrogen and oxygen post-monitoring involves other exemption requests that have already been approved by the staff recommended that the Commission would approve them. And the exemption request number two, which would have required an active system to control hydrogen concentration and containment, we've deemed it not necessary, and we've approved that.

The exemption request for the post-accident sampling system, which is really the grab samples from the RCS and the containment, was approved predicated on the fact that hydrogen and oxygen monitoring, monitoring the containment atmosphere with this closed loop flow path we've talked about, that that would be in effect.

So these two other exemption requests are somewhat conditional upon or significantly conditional upon having hydrogen and oxygen monitoring. So that's the status of the review as of today.

MEMBER MARCH-LEUBA: Anne-Marie, let me be the bad guy. How can the staff decide to credit the capability of monitor H2 and O2 concentrations if you don't know that it works? I keep asking you what is the flushing time, and you tell me I don't know. You're telling me I don't know that the system they're proposing to use actually performs the function they claim.

MS. GRADY: The flushing time has not, as you heard earlier, has not been established yet. But we have time to flush. So as far as I'm concerned, timing to take this action is important but not critical. There are hours if not days to do it. And I don't really care if it takes an hour or two hours at all, as long as you can establish a representative sample.

MEMBER MARCH-LEUBA: What if it's 100 hours?

MS. GRADY: Pardon?

MEMBER MARCH-LEUBA: What if it's 100 hours? What is your limit?

MS. GRADY: Well, we probably -- probably, this is speculation, we probably have 100 hours past the 72 in order to, if we have to, flush it. So the timing is not that critical. And actually, I was going to get into the timing in a later slide.

MEMBER MARCH-LEUBA: All I'm asking, I think we're asking, is does, they're proposing to do something that is very counterintuitive, which is opening a -- counterintuitive, which is opening a four-inch line, de-isolate containment, and put in all your environmental containment out there in a system that is non-safety grade.

MS. GRADY: Yes.

MEMBER MARCH-LEUBA: All I'm asking is does it work for the intended purpose. And neither the applicant nor the staff tells me I've looked at the functioning of the system they propose and I'm happy with what they're proposing. You don't tell me that.

MS. GRADY: The system hasn't been designed in detail. There are no line sizes, there are no flow rates, the sample pump hasn't been specified, well --

MEMBER MARCH-LEUBA: What requirements would you require? I mean, there should be some requirements put on the COL --- if it takes 1000 hours to flush it, it won't work. You have to tell me what is the limit, and then I'll shut up.

MS. GRADY: What I do know about the containment is that it's going to be under pressure somewhere between 70 pounds and 250 pounds, that's number one. So there's going to be a, there's going to be a back pressure on this sample pump. Then there's going to be a sample pump that's going to take into consideration the line sizes.

And I have confidence that any reputable engineering company could come up with a sample pump that would do the job, and it hasn't been done yet.

But I'm not concerned that they can't do it, that there would not be, in fact, a flow path established. And it would sample from where they take off in the containment.

MEMBER PETTI: So Jose, I'm reading the ANSI -- I'm trying to get it.

MEMBER MARCH-LEUBA: You found it?

MEMBER PETTI: Well, I'm looking, and I'm finding, I'm not sure if it's bits and pieces, it's kind of weird. But there is, again, it's for sampling stacks.

MEMBER MARCH-LEUBA: Yes.

MEMBER PETTI: So these are really large diameter with small, so you know, four inches is, a stack is bigger than four inches. So there's some commonality, but again, they're worried about a slightly different issue, particulates and isokinetic sampling. But there is discussion in here about the transmission efficiency, the considerations in the design of the transport line to maximize the transmission efficiency. So you know, that in my mind means so it doesn't take forever.

PARTICIPANT: Minimize the flushing.

MEMBER PETTI: Right, right. I mean, you know, I'll keep digging, but I see stuff that if you're going to follow the standard, there may be some guidance in here that could be helpful.

MEMBER MARCH-LEUBA: I'm ecstatic that you have found it, but I don't think the staff has reviewed it, have you?

MS. GRADY: I don't know. And just as a clarification, this isn't a four-inch line size. The CES is four at the CIVs, it necks down to two inches. And then going through the sample pump and the line monitor, it's three-eighths of an inch. We don't know the lengths of each of those dimensions, but it's not a four-inch flow path.

And then going back in through containment flooding and drain, that's a two-inch line at the CIVs. So there's a lot of line size changing and we don't know the lengths, so we don't know the volume yet. It will be known. Okay, next slide.

Now, we have discussed this topic -- no that's good. We have discussed this topic before with the ACRS, and we have understood, not only in discussions but also in your accident source term letter, that you have two major concerns, I would say.

One of them is do we really need to monitor hydrogen and oxygen. And the second is, if we need to, is the design going to work. So these first two slides I have explain to me, at least, to my satisfaction that we do need to monitor post-accident hydrogen and oxygen.

We need to do it in order to be, to inform the timing of the following actions. Whether or not the mitigating action is going to inert the containment with nitrogen using CVCS and the nitrogen distribution system. Or if we take action that's in the GTGs, which is to vent the containment, routing the gas either through the stack or into a radioactive gas waste.

And we also need the hydrogen and oxygen monitoring to confirm that either of those two mitigating actions have been successful, whether or not we might need to repeat the action or we're good for a while.

And we also, because there are going to be EOPs and there are going to be SAMGs, and we've already seen, we have already seen the GTGs that are intended to be the basis of that, we realize that the concentration of hydrogen and oxygen has already been identified by NuScale as being an important data point for in fact taking a mitigating action.

MEMBER BLEY: Can I ask you a question about the venting?

MS. GRADY: Yes.

MEMBER BLEY: That's in the GTG, as you said.

MS. GRADY: Yes, that's the action to take.

MEMBER BLEY: On our boiling water reactors a couple years -- several years ago when we were looking at post the accident, NRC decided, Commission decided they didn't need filtered vents because we get substantial filtering in the pool. There's no filtering here, right? This is just going to put containment atmosphere straight outside.

MS. GRADY: I think the flow path is through a filter to the stack.

MEMBER BLEY: Designed to handle fission? This is not the normal stuff you'd be filtering in normal operation.

MS. GRADY: No, it is not, but this supposed to be our accident, this is --

MEMBER BLEY: And that, is the filter supposedly designed for that?

MS. GRADY: I don't know.

MEMBER BLEY: I don't either. But I know when we looked at fan coolers and PWR containments, it was a real issue that probably they won't work because they'll plug up and then they'll melt from the heat source, from the fission products post-accident because that's not the atmosphere they designed to work in.

So either the filters might plug or they might disappear. So it could be a, just a direct release outside of the stuff that's in containment. You didn't look at that.

MS. GRADY: I did not look at the filter, no. But venting the containment is the action, the mitigating --

MEMBER BLEY: In the GTGs.

MS. GRADY: That NuScale has identified as the action to take, yes.

MEMBER BLEY: Okay, thank you.

MS. GRADY: Next one.

MS. PATTON: We have Boyce Travis available to answer any questions, the earlier question.

MEMBER BLEY: Okay.

MR. TRAVIS: So there were some questions about mixing. I wasn't here for the discussion, so if anyone could repeat the question, I could probably answer it.

MS. GRADY: On the ANSI standard.

MEMBER BLEY: There were two questions there. We, I think we understand that you looked at mixing, there would be mixing inside the containment up to 72 hours.

MR. TRAVIS: Inside both the containment and the RCS, yes.

MEMBER BLEY: Okay, we're focused on the containment on this. And then NuScale told us that they need to meet ANSI N13.1-2011, which requires sampling the representative. And my question in that area is are you, did you look at that, and are you convinced that meeting that ANSI standard is adequate -- will give adequate confirmation that we'd get representative sampling through that system in a reasonable time following an accident.

MR. TRAVIS: So I'm not familiar with the specific ANSI standard. When I was looking at mixing, I was looking at it more from an engineering perspective in terms of the motivators behind mixing, which is there's a temperature differential between the containment at the pool and the RCS and the geometry that doesn't lend itself well to having an area that would concentrate hydrogen.

And so based on some experimental data that had been performed and a look at some of the nondimensional numbers that were present in the containment region, we came to a reasonable assurance finding that a sufficient amount of mixing would exist up to 72 hours and some time beyond 72 hours.

MEMBER BLEY: In containment.

MR. TRAVIS: Within the containment, yes.

MEMBER BLEY: Okay, and I guess then as far as we know, and as far as the staff who are here know, nobody's really considered that. And I think all we have to go on is engineering judgment from the staff that when they design this, they'll make sure they get adequate flow through the system and it will be represented. But no reliance on the standard --

MR. TRAVIS: No, that's correct.

MEMBER BLEY: Okay, thank you.

MS. GRADY: Okay, I also believe that we need post-accident hydrogen and oxygen monitoring to inform the timing of operator action to avoid the following. And that is risking an impulse pressure to the inside of the containment vessel, which --

PARTICIPANT: We cannot hear.

MS. GRADY: I'm sorry. Okay, I also think that we need the post-accident hydrogen and oxygen monitoring to inform the timing of the operator action to avoid risking an impulse pressure to the inside of the containment vessel, which at 45 days would be approximately double the impulse pressure at 72 hours.

Now, at 72 hours that impulse pressure was deemed to be not threatening the containment after a structural evaluation by NuScale. But they didn't go, as Dr. Corradini has elicited, they didn't go beyond that to see --

MEMBER BLEY: Because of the short duration of the ---

(Simultaneous speaking.)

MS. GRADY: Exactly, okay. But at 45 days, the impulse pressure is now double what it was at 72 hours. The impulse pressure at 72 hours was evaluated structurally. The dynamic flow of this converted into a static pressure. The static pressure was then compared on the vessel itself and also on the flange bolts of the larger bolted flanges.

And it was found that the vessel could withstand at 72 hours and did not exceed the ASME Service Level D limits, which is what DDT loads are compared to. However, they did notice that the CRDM access flange, which is the big one, 67 inches up on the top of the reactor vessel top head, the flange bolt load was about 85% of what was allowable at 72 hours, okay.

So that's probably if it were going to fail and if you kept increasing the pressure, that was probably the location of a most likely failure point. But at 72 hours, it wasn't exceeded. Now we get to 45 days and they doubled the impulse pressure. And Anne-Marie Grady, who is not a structural engineer, thinks we're probably going to exceed the Service Level D allowable loads on those flange bolts.

I take that -- I offer that as engineering judgment, there is no calculation, but that's a point of reference. And I think if we think that, and I think it, then we ought to avoid it. And we ought to avoid it by knowing what's going on in the containment.

MEMBER RICCARDELLA: And those bolts are on the reactor vessel flange or containment flange?

MS. GRADY: Oh, I only talk about the containment, so on the containment vessel.

MEMBER RICCARDELLA: Okay.

MS. GRADY: This to get access to --

MEMBER RICCARDELLA: All right.

MS. GRADY: Yeah, that's correct. And if we don't damage the containment and exceed the allowable limits on the flange bolt or something else almost as vulnerable, then we would not be risking an uncontrolled release to the public.

Now, as for capability, this is why I think that the system is going to work and is going to be able to gain representative samples and gain useful information in order to take mitigating actions. First of all, it's a closed-loop monitoring flow path. It's established when the containment pressure is below 250 psig, which is the design pressure of the CES, the post-accident -- the sampling system and the containment flooding and drain system.

It requires un-isolating the CES and the CFDS isolation valves. It creates a flow path through the sample pump and the in-line gas monitors and returns it to the containment vessel. The flow path is non-safety related, as NuScale has said, as is acceptable for equipment specifically used for mitigating a severe accident, per SECY-90-016, under the topic equipment survivability.

So except for the containment isolation valves, everything else is non-safety related. And I know everybody here is aware of that fact.

Okay, in the SER phase 4, Chapter 6, the staff concluded the entirety of the containment, both in the annular region and the dome, would be mixed at 72 hours, as Boyce has said. And that was is review.

NuScale asserts post-72 hours that convective mixing is driven by decay heat, and that there are no subcompartments to impede mixing. Both points of which I agree.

If the non-condensables rise to the, meant to be CNV dome, without mixing, conservative values of oxygen and hydrogen readings would result, and we'd just be taking earlier action.

DR. SCHULTZ: So Anne-Marie, you said that NuScale has asserted this, and then you've just said that staff agrees.

MS. GRADY: I've said staff agrees convective mixing is driven by decay heat and there are no subcompartments, yes.

DR. SCHULTZ: Thank you.

MS. GRADY: Oh, the last, I see your point. The last sentence is my conclusion.

DR. CORRADINI: Right, but there is data from other designs and other large scale experiments that show an open system, you will pool non-condensables at the top due to condensation.

MS. GRADY: Yes.

DR. CORRADINI: So I'm not disagreeing with what your conclusion is, but I'm only saying that there's data that confirms that sort of behavior.

MS. GRADY: Yes.

DR. CORRADINI: Okay.

MS. GRADY: Okay, in the A -- in your ACRS accident source term letter, you had some comments or questions about the rationale for longterm post-accident monitoring. Your letter states that, quote, Weeks are available before monitoring information is needed to inform mitigating actions. The staff elaboration on that is the following. Combustible mixtures, which means five percent oxygen, would occur at 45 days. This in the FSAR, Chapter 19.

There's also at 30 days a minimum concentration of four percent oxygen, which has been shown experimentally to allow combustion. So maybe it's not 45 days, maybe we could have combustion at 30 days.

Okay, now wondering what this would mean in terms of identifying the time when the oxygen concentration would not support combustion, I looked at our confirmatory calculation, which was just a production by -- of hydrogen and oxygen from radiolysis, very similar to what NuScale did.

And I eyeballed three percent. And three percent occurs at about 15 days. So if you thought there was a safe time, combustion was not going to be really possible and you could still take action, I would say you could wait up, it would occur at around 15 days. My staff recommendation is that if you start monitoring as early as 72 hours and no later than 15 days, you would avoid the combustion and the potential DDT conditions that could follow combustion.

So, it doesn't, I was trying to point out we don't have weeks, the timeframe is shorter.

MEMBER BLEY: I'm still thinking back where I was on several slides ago. If we have a vent path that's not going to be filtered, somebody at NRC and somebody at the power plant are going to have to be very brave to open that flow path. And those of us who sit here and say, well, we might get into trouble with a hydrogen burner explosion have to be, will be weighed against well, how likely is that and how likely is that to break anything.

And do I really want to open this thing up and start dumping it to the atmosphere. And with, you know, on a filtered vent I think that was a real concern when we first -- on a vent for the boilers, that was big concern initially. But once we thought enough about how much filtering you get in the pool and people were really trained on it, I think that concern has abated.

But on a plant that wouldn't have any filtering, I'm not sure. I think that's going to be pretty darn tough spot we're putting people in. But let's go ahead, I'm just making that comment off the top of my head.

MS. GRADY: Okay.

MEMBER MARCH-LEUBA: So, what is in the containment? What's the chemical composition of the containment on --

MS. GRADY: Other than hydrogen and oxygen and some steam boiling off?

MEMBER MARCH-LEUBA: There won't be any steam. Everything is condensed. This is steam to be moisture.

MS. GRADY: Other than hydrogen and oxygen, I don't know what else is in the containment. Some residual nitrogen, but I don't think it's --

MEMBER MARCH-LEUBA: Iodine, strontium, xenon?

MR. STUTZCAGE: All the radionuclides will be there. Most of the iodines would be largely decayed away, but there will be some still there.

MEMBER MARCH-LEUBA: But you said the pressure was to be 250 psi?

DR. CORRADINI: That's what I thought was the capability of the flood and drain line.

MEMBER BLEY: It has to be less than that before you open up the containment, is what they were saying.

MS. GRADY: Yes, that's correct.

MEMBER MARCH-LEUBA: The question I'm leading to, is there going to be sufficient pressure in containment to be able to force a flow out of it?

I mean, is the pressure going to be greater than atmospheric if all you have is a little bit of hydrogen and oxygen in a big volume?

MS. GRADY: Well, they're producing hydrogen and oxygen by radiolysis. We are increasing the pressure all the time.

MEMBER MARCH-LEUBA: Is it sufficient to create how much pressure?

MS. GRADY: Well, there's also going to be a sample pump that's going to draw from the containment as well as the back pressure in the containment.

DR. CORRADINI: But if we could -- I'm assuming NuScale is still on the line. Since they did some conservative calculations, 72 hours, would they be willing to say what the pressures are that they're computing at 72 hours to answer --

MEMBER MARCH-LEUBA: Yeah --

DR. CORRADINI: -- your question?

MEMBER MARCH-LEUBA: -- that would be nice. At 72 hours I wouldn't expect any steam to be left there other than humidity. I mean, we have steam in this room.

MS. GRADY: I don't know what the total pressure is at 72 hours.

I do know that NuScale has looked at the containment atmosphere just looking at the increase in pressure to move to the production of hydrogen and oxygen from radiolysis.

And at 72 hours, it's approximately 70 psi, but that's just -- well, yeah. It's just -- that's just through the -- from radiolysis.

If there was already pressure in there, it would be more.

MR. TESFAYE: Perhaps we have some information --

MEMBER MARCH-LEUBA: So, you're saying 70 psi of hydrogen and oxygen.

MS. GRADY: Plus whatever was there when -- yes, I am saying that at 72 hours. And at 60 days it's about 150 psi.

MEMBER MARCH-LEUBA: Boyce maybe -- okay.

MR. TRAVIS: Yeah. So, this is Boyce Travis again.

So, for some context, like, this is not a simply analysis, per se, because it depends on the degree of core damage and the amount of radiolysis that's happening.

MS. GRADY: Uh-huh.

MR. TRAVIS: So, it could be a range of pressures from on the order of, you know, 20 to 40 up to -- like Henry (phonetic) said, up to 150 depending on how long in the event you are, and what the degree of core damage, and how much clad-coolant interaction there's been, plus the radiolysis that's happened as a result of the event. So --

MEMBER MARCH-LEUBA: So, roughly, it could be up to 150 psi of --

MR. TRAVIS: At 72 hours, I would guess tens of psi. As the event transpires 15 days, 100 to 150 psi is probably a good estimate.

MEMBER MARCH-LEUBA: I don't just throw -- you know me, guys. I don't just throw wild things. Why don't you monitor the pressure?

MS. GRADY: I beg your pardon?

MEMBER MARCH-LEUBA: Why don't you monitor the pressure?

If the main contributor to pressure in the containment is hydrogen and oxygen, why do I need mass spec or an infrared system? I measure the pressure.

If the pressure goes above 100, you vent it.

MR. TRAVIS: Yeah. And so, the reason -- part of the reason for that is you don't know the constituents that are going into the containment.

So, if you had a severe core damage event, it's going to be almost all hydrogen and the radiolysis is producing hydrogen and oxygen stoichiometrically.

If you had a core damage event that was less severe that only had a -- let's -- you know, tens of percent of clad-coolant interaction, you generated less hydrogen initially, but your radiolysis is generating stoichiometric hydrogen and oxygen until you get to that combustible mixture that Henry has discussed.

MEMBER MARCH-LEUBA: Let's assume you release all the gases that are contained in the UO2 pellets, all of them. What would be the pressure that you would be getting in containment? Not the 100 psi.

So, you are going to extremes to measure the oxygen when you could just measure the pressure.

DR. CORRADINI: But I think it's -- I thought what Boyce was saying was it's a non-unique value.

You could have various combinations of hydrogen and oxygen and steam concentration to get the same pressure. That's what I thought the --

MR. TRAVIS: That's exactly right. The pressure just tells you how much gas has been generated.

It doesn't tell you what the constituents are in the mixture of hydrogen/oxygen, which is the concern at issue.

MEMBER MARCH-LEUBA: The oxygen is almost a constant reaction by radiolysis. It comes from the high-energy gamma rays and you have a pretty good correlation for radiolysis.

I think it's extreme to an isolated containment to do something you can bound simply by other measures, but that is me. You know me. I'm different. Especially when I keep asking, does the system work? And you -- nobody can tell me the system actually works.

CHAIR KIRCHNER: It hasn't been designed.

MS. GRADY: Yes, that's --

MEMBER MARCH-LEUBA: It hasn't been designed, but you don't have a spec that says it must work at least this well.

If you tell me how well it needs to work, I'll shut up and put you on your ACRS and say, okay, whatever you do the sampling, you have to be able to sample -- the representative sample on the containment means you cannot have a delay longer than 14 hours.

You make up your mind how many hours you are willing to take a delay on, and that becomes a spec that they have to meet and they'll design it.

But right now, you cannot tell me it doesn't have a 1,000 hours.

MS. GRADY: As long as we can sample in enough time to take mitigating action --

MEMBER MARCH-LEUBA: I can't hear you.

CHAIR KIRCHNER: You're just very quiet. You're soft-spoken. You have to really speak out.

MS. GRADY: Okay. As long as we can sample in time to take mitigating actions, I'm not particularly concerned about --

MEMBER MARCH-LEUBA: I am.

MS. GRADY: Why? We want to protect to containment integrity, we don't want to have it to fail.

As long as we can take action in time -- let's say 15 days is the answer. What do you care?

MEMBER MARCH-LEUBA: The problem is you are protecting the containment integrity, containment which is all under the water, by opening the containment to this vent that Dennis was talking about.

MS. GRADY: But if we open it up at a time when there's not going to be any combustion events in the containment, we're not risking anything.

It's going to be an intact flow path; isn't it?

MEMBER MARCH-LEUBA: It's very counterintuitive and it -- you should have a specification that says, this sample system should work as well as this.

MS. GRADY: Okay.

MEMBER MARCH-LEUBA: And then --

MS. GRADY: But this system is a severe accident mitigating system and it hasn't been fully designed yet.

MEMBER MARCH-LEUBA: Yeah. So, the -- when I'm designing the system -- because I'm going to start working for them now.

Five years from now when I design the

system, to what specification do I need to design it for? I don't know. I don't understand.

I mean, you say, I want to have hydrogen and oxygen, I need it, I need it, I need it. I agree. But then you say, but it okay if it doesn't work.

MS. GRADY: No, I didn't say that.

MEMBER MARCH-LEUBA: Yeah, that's what you said.

MS. GRADY: I don't care how long the flush time is as long as we get a representative sample and we get the information early enough so we can take action and avoid the DDT, et cetera.

MEMBER MARCH-LEUBA: So, there has to be a set of requirements or specifications or goals that the design must satisfy.

MEMBER BLEY: If they had argued that the standard gives you that, I'd be more content, but --

MEMBER MARCH-LEUBA: I'm trying to get it here, but they want $70 for it.

(Discussion off the record.)

MS. GRADY: You can get it online, though, from the NRC, Jose.

MEMBER MARCH-LEUBA: We will -- over lunch we will find out.

CHAIR KIRCHNER: Anne-Marie, one of the

things that occurred during our interactions with you, if my memory is correct, you postulated a leakage rate for this system.

MS. GRADY: I did not.

CHAIR KIRCHNER: You didn't?

MS. GRADY: That wasn't my part of my review.

CHAIR KIRCHNER: Somewhere we were presented material --

MS. GRADY: We have.

CHAIR KIRCHNER: Yeah. Sorry, I didn't mean to --

MS. GRADY: Okay.

CHAIR KIRCHNER: -- impugn you personally, but the staff -- and I'm not impugning the staff, no. I'm just recollecting that the staff presented us material that suggested a leakage rate which would lead to a dose.

And that also informed our thinking because that was of concern. And it wasn't clear what that dose was going to be, but I will say it was not insignificant.

It wasn't consistent with ALARA. So, that was part of the thinking. I've been going through the viewgraphs and I don't see that anywhere, but there was some analysis done.

Was that you, Ed?

MR. STUTZCAGE: Yeah. That was Michelle Hart --

CHAIR KIRCHNER: Michelle Hart.

MR. STUTZCAGE: -- and she can speak to it. She's here. But, yeah, that was based on maximum acceptable leakage rate for a sampling system in the ANSI standard --

CHAIR KIRCHNER: Right.

MR. STUTZCAGE: -- and the range of flow rate.

CHAIR KIRCHNER: Right.

MR. STUTZCAGE: So, we don't have the specific information, but it was based on those values.

And I believe -- I mean, yeah, the values could exceed the part 100 dose limits at the upper end of those flow rates.

CHAIR KIRCHNER: And that was part of the information we were presented. And that was one of the things that kind of got us thinking it was another trigger, if you will, to say, okay, what's the -- what's the risk-informed balancing here of doing this and exposing the operators and a potential offsite dose for something that was of uncertain value.

And that informed our thinking as well, and I don't see that in those viewgraphs.

MR. TESFAYE: That's the reason for the rule carve-out that we'll be discussing.

CHAIR KIRCHNER: Okay.

MR. TESFAYE: We have not reached any conclusion on that aspect of the design. So, we're not making any decision --

CHAIR KIRCHNER: Okay.

MR. TESFAYE: -- on the leakage because we don't have enough information.

CHAIR KIRCHNER: But I just want to point out that that weighed in our thinking that, you know, you raised the fact that there's the potential for this exposure and release.

And then we're saying, well, how valuable is this information when if we think what has happened has happened and there are other ways to ascertain that, let's go ahead and inert the containment and be done with this.

That's one person's opinion, by the way. I would go right to inerting the containment. I have experience with inerted containments and I -- and then we're done.

MS. GRADY: Well, if we inert the containment, let's say, at 72 hours immediately --

CHAIR KIRCHNER: Right.

MS. GRADY: -- we still need to confirm that it is inert, that we've added enough nitrogen. So, we'd still need to --

CHAIR KIRCHNER: So, I would design it -- we're not in the design business --

MS. GRADY: I know.

CHAIR KIRCHNER: -- but there are better ways to get that information without un-isolating containment.

Anyway, go ahead. Go ahead go through.

MEMBER REMPE: Can I ask, why didn't you vent earlier and sample as you vent? I mean, basically it takes a while for a severe accident to progress.

Did that get considered?

MEMBER MARCH-LEUBA: That's what they're doing. They're venting to the CES.

MEMBER REMPE: Right. But if you do it --

MEMBER MARCH-LEUBA: They don't vent to the environment.

MEMBER REMPE: Yeah. But if you would vent earlier and monitor before 72 hours, you could see how -- and you know it's not combustible then.

But if you started doing it really early -- it's the rules of the game and you can't do that? I mean, maybe the game rules ought to be changed. It's just --

MEMBER MARCH-LEUBA: Well, sorry. I'm going to say what he said before, because the reason I'm complaining about this was because what we have here is that if I open the isolation valves, I render the operator/the control room inoperable. You told us --

PARTICIPANT: Potentially.

MEMBER MARCH-LEUBA: Potentially.

PARTICIPANT: Not --

MEMBER MARCH-LEUBA: And I said, well, I'm going to render my control room inoperable, potentially, for what?

If we need oxygen monitoring, which I know you do believe it and I think I want -- I want to have it too, let's build it right. Let's build one that works.

I have no confidence that this one works. That's what I'm saying.

MEMBER DIMITRIJEVIC: I want to also make sure that -- because I did already make the point and I said, if they open this before 72 hours as currently they have in PRA, they would not satisfy safety goal.

If this valve is opened before 72 hours, safety goal is not of the condition or containment performance is burned because it will be one. It's 10.1, yes.

MEMBER RICCARDELLA: Wait. Wait. The probability if they open that valve into the CES system, the probability of that not -- of that leaking or not containing is not one.

MEMBER DIMITRIJEVIC: Yeah, but they're not taking credit for non-safety system. So, they have to assume --

MEMBER RICCARDELLA: Wait.

PARTICIPANT: It's up to 19.

MEMBER DIMITRIJEVIC: Yeah. So, how model is set --

MEMBER RICCARDELLA: So, after 19, we don't --

MEMBER DIMITRIJEVIC: Yes.

MEMBER RICCARDELLA: -- take credit for non-safety systems?

MEMBER DIMITRIJEVIC: No. In containment isolation, no. So, the thing is -- for containment isolation, for everything else --

(Laughter.)

MEMBER DIMITRIJEVIC: -- non-safety system.

I just want to say that's probably not true, I mean, that this -- I mean, probably they're not going to have a large release in that time and probably the system will not leak.

But how I would model the set currently, that's what I say. How model is set currently, if they open it before 72 hours, the condition of containment probability is one.

MEMBER RICCARDELLA: But that's fixable.

MEMBER DIMITRIJEVIC: Well, they have to fix the PRA. It's a different story.

MS. GRADY: But, as you know, it's not modeled to be opened for this action before --

MEMBER DIMITRIJEVIC: No, I know.

MS. GRADY: -- 72 hours.

MEMBER DIMITRIJEVIC: I know. I know. Yeah, but that's what I'm questioning. So, I want to say if they commit that this is not -- I mean, if there is a guarantee they're not going to open before 72 hours, the PRA is fine.

MS. GRADY: That's why they did the structural analysis --

MEMBER DIMITRIJEVIC: Right.

MS. GRADY: -- for 72 hours --

MEMBER DIMITRIJEVIC: Right.

MS. GRADY: -- exactly.

MEMBER DIMITRIJEVIC: Right. Okay. I just want to make sure that if they open before 72 hours, they have a different safety goal problem as the model is set now.

MS. GRADY: I understand your point.

DR. CORRADINI: So, my interpretation -- I know you have a couple slides to go through, but I'm just trying to understand the logic.

So, the logic is that the carve-out is until there is a calculation based on the current design to show that it's acceptable in terms of dose aspects, the concept is acceptable once that is shown.

So, that means they can come back -- the COL applicant can come back and say, we're going to ask for a design change, we're going to ask for an improvement in the pressure rating of the system, we're going to ask for an exemption. That's totally up to the COL applicant later.

So, everything is on the table given the way this is done as you're proposing it.

MR. TESFAYE: Yeah. The exemption part I don't think is going to be a solution, but design change or calculation or leaking -- leakage information --

DR. CORRADINI: Okay. All right.

MR. TESFAYE: -- yeah.

DR. CORRADINI: Okay. I just wanted to make sure I understood the parameters of what the carve-out meant.

MR. TESFAYE: Yeah.

DR. CORRADINI: Understood.

MS. GRADY: The carve-out only relates to leakage from this --

DR. CORRADINI: Correct.

MS. GRADY: -- path.

DR. CORRADINI: Understood.

MS. GRADY: Not monitoring.

DR. CORRADINI: Understood.

MEMBER MARCH-LEUBA: Okay. So, we don't know whether it works or not and we're not carving that out?

MS. GRADY: Pardon?

MEMBER MARCH-LEUBA: Alright. I'm beating a dead dog or a dead horse here, but the fact that the monitoring system should actually perform the intended function, which you have no confidence now that it does -- you cannot tell me that -- I have no confidence in this, that should be part of the carve-out, too.

MS. GRADY: I've told you why I have confidence it's going to work. Perhaps we could move on.

MEMBER MARCH-LEUBA: But I have no --

CHAIR KIRCHNER: Yes.

MEMBER MARCH-LEUBA: -- basis to judge that belief.

MS. GRADY: Okay.

MEMBER SUNSERI: Well, I mean, this won't help you any, but I feel obligated to say it. I used to do startup testing on power plants under construction and, you know, I did the post-accident sampling system and there would be a measurement of the purge time required to get a representative sample.

Because of the as-built configuration, there would a leak test. There would be making sure that you could get a representative sample. So, there would be testing done to prove that the sampling system worked as it intended.

I think your question is, is what's intended here, right?

MEMBER MARCH-LEUBA: Yeah.

MS. GRADY: And there is a difference

between systems that you use for normal operation, as you've just identified, and something that's only there for severe accident mitigation. Okay.

MEMBER SUNSERI: Just to put an exclamation point on my point, if there's going to be a system design to do this, there will be criteria associated with that design that will be tested as part of the commissioning of the plant.

And they will ensure that it works before they --

MEMBER MARCH-LEUBA: Who defines the criteria. Why are they --

MEMBER SUNSERI: Yeah, I don't know.

MEMBER MARCH-LEUBA: Why can't nobody tell me what the criteria -- that's what I'm saying. It shouldn't be criteria I can test my system against.

You certified the design would work and you cannot give me the criteria I have to test it again.

MS. GRADY: I'm satisfied that the applicant has considered the important aspects of the design and they're committing to having it work. That's what I'm satisfied with given that it's in the severe accident management guidelines.

Okay. In the ACRS letter on AST, you also have another item, Item D, and you make a statement that there's outer pressure, temperature and radiation sensors available to follow severe accident progression.

And that is what they are for, but they're not there for identifying potential combustion of gases.

And in the -- my clarification here is from the equipment survivability design. When you look at the component of the variable, the wide-range containment pressure is going to be qualified until core damage. Not 72 hours. Certainly not 60 days.

The narrow range containment pressure is going to be qualified up to an hour after the transient.

The under-the-bioshield temperature indication is going to be qualified for one hour after the transient.

And the under-the-bioshield radiation monitor is going to be qualified for 24 hours after core damage.

So, this indication of temperature, pressure, radiation sensors are, by qualification, not going to even be available. And furthermore, they don't tell you anything about the potential for combustion.

That's just a clarification on your point in the letter.

MEMBER PETTI: We allow non-safety systems. I mean, these things will be used by the operators.

They're not going to go, oh, no, that was outside of qualification in the real --

MS. GRADY: No. I was just trying to give you a point of data that they might not be --

MEMBER PETTI: They might not be, yeah.

MS. GRADY: -- there to use. They'll use whatever works, I'm sure.

MEMBER PETTI: Right. Right.

CHAIR KIRCHNER: But they're really no different than a lot of other systems where you don't require non-safety -- where you don't require safety grade for post-accident qualifications.

I mean, it works both ways. These aren't just going to disappear.

MS. GRADY: Okay.

CHAIR KIRCHNER: Yeah.

MS. GRADY: And we probably all expect that they would be functional, but bottom line is they still don't tell you anything about hydrogen and oxygen.

They tell you what's going on in the containment in other ways or outside the containment under the bioshield.

CHAIR KIRCHNER: Uh-huh.

MS. GRADY: There were a lot of discussion in an earlier ACRS session/meeting about alternatives that did not require un-isolating the containment.

NuScale has not proposed any, we have not thought of any. All of the accident -- all of the ways of obtaining this information, that we know of, require un-isolating the containment.

And the options for actions are, as we've talked about before, inerting or venting.

MEMBER REMPE: Again, I know -- I guess I fully don't appreciate the rules of the game, but it's just like you're talking about injecting nitrogen if the applicant were to say let's vent earlier and then monitor what's going on, because usually you don't get core damage early in an event.

That could alleviate things a lot easier if --

MS. GRADY: Core damage basically takes place and is finished long before the 72 hours is up.

MEMBER REMPE: Right.

MS. GRADY: It's the radiolysis we're concerned about.

MEMBER REMPE: So, it seems like you could continue to monitor from the venting and understand and anticipate before you get to combustible configurations earlier.

MS. GRADY: Well, yes. The design is --

MEMBER REMPE: Yeah.

MS. GRADY: -- the design is meant to continuously monitor.

MEMBER REMPE: Right now, your second bullet was what I was trying to suggest, venting it earlier and having it get directed, right?

MS. GRADY: No. Those are the two mitigating --

MEMBER REMPE: Right.

MS. GRADY: -- actions that have been recommended and the design supports.

MEMBER REMPE: And if they were to do that, couldn't they vent and monitor through that second bullet, is where I was trying to go.

MR. STUTZCAGE: Yeah. I think venting here --

MEMBER REMPE: They're blowing out a stack.

MR. STUTZCAGE: Venting here is to the atmosphere. I think you don't want to do that for the radiological reasons unless you really have to.

MEMBER REMPE: Earlier is better than later.

MS. GRADY: No.

MR. STUTZCAGE: No. No. The radiation doses would be higher earlier.

MEMBER REMPE: Well, it depends on how early you're talking about.

DR. CORRADINI: Well, I think we're back to the assumptions. They're assuming a severe accident. So, it --

MEMBER REMPE: We don't have the option that people typically have in a severe accident. You have to assume --

DR. CORRADINI: They're not mitigating the accident. They're assuming there is one and now deal with it.

MEMBER REMPE: Okay.

MS. GRADY: Okay. And my last real slide was we were asked if we had done -- if one had been done, a risk evaluation for monitoring versus non-monitoring. And I tried to put this in a little table to make it -- to compare the different options.

And if the operator takes an action, the timing of the action, whether or not they could prevent DDT, whether or not the monitoring path was isolable and what the results were, and venting or inerting if you do it between 72 hours and 15 days, as far as I'm concerned, there's plenty of time to do it.

The hydrogen and oxygen monitoring flow path is isolable. Yes, it is. There are limited numbers of reclosing of the containment isolation valves after you've taken that action that NuScale has taken credit for in their design. It's in the FSAR.

If you do take the -- either of those two top actions, you prevent DDT from occurring and, therefore, opening the containment isolation to take those actions will not lead to a large release.

MEMBER BLEY: And why is that? You've had a core melt and now you're venting either up the stack or to the rad waste system.

MS. GRADY: It would be a release, but it wouldn't be a large release because by that time a lot of the aerosols have dissolved back into the --

MEMBER BLEY: Okay. Just the decay and --

MS. GRADY: Yes. Exactly.

MEMBER RICCARDELLA: Excuse me a moment. What's DDT?

MS. GRADY: That's the deflagration-to-detonation transition. It's the one that gives the highest pressure class.

MEMBER RICCARDELLA: Okay. Thank you.

MS. GRADY: If you don't take action, however, there's nothing for the operator to do. We don't have to worry about reclosing the containment isolation valves, but you have a potential failure.

And in my case, the example was the CRDM access flange bolts failing after about -- after 15 days.

So, you risk an open containment and that's the -- probably the likely location it would be opened.

MEMBER MARCH-LEUBA: Okay. I wanted to give you some -- why I'm so vocal about this. I have experience with sampling systems.

When I was in R&L, we used to run a UF6 loop which was pipes about this small running in the loop.

The volume is minimal, and we were sampling that loop to know the partial pressure of UF6 through an infrared system like every ten minutes.

The pressure in the loop, a volume the size of this, didn't change over a week. And we were sampling it and we were measuring the content of UF6, and the partial pressure of UF6, and we didn't sample this much volume at ten millimeters of mercury absolute pressure.

Okay. If you use the system I was using to measure that for the period infrared system, you will never ever empty the CES four-inch pipe.

I mean, I tell you in a week, I never empty this much volume -- I'm holding a coffee cup -- at 10 millimeters of mercury absolute pressure.

So, the criteria and the requirements for that psi system, how much flow you go through there, it's important that -- the system I was using, which would work perfectly for your purposes, would not ever get a representative sample for the containment, ever.

So, you need to establish some kind of bypass flow around your sensor so that you actually suck something from the containment so that the CES is representative -- okay.

I'm telling you the system, I was using in Oak Ridge to measure UF6, would not work for this.

MS. GRADY: I think what you're saying, it's impossible to size a system that would work and do this, and I think you're wrong and it hasn't been sized yet.

MEMBER MARCH-LEUBA: Okay. You can decide this thing wrong.

MS. GRADY: Yes.

MEMBER MARCH-LEUBA: Right. So, there should be some criteria set for how well it works. I think by bringing it up, again, in the -- to give it publicity on these meetings, the applicant will probably design it right.

MS. GRADY: Committing to establish a representative sample is a criteria.

MEMBER MARCH-LEUBA: Ma'am, a criterion that has not been given much thought.

MS. GRADY: I agree on my part. I don't know how much thought has been given by the applicant.

MEMBER MARCH-LEUBA: Nobody can tell me what the flow rate is through the sampling system. Nobody can tell me what the volume is.

I agree with you that an oxygen monitoring the system is extremely valuable and should be there.

I'm insisting that if you are going to open containment, at least ensure that the system works, right?

And I don't get any confidence that anybody has given any thought about how the system works.

MEMBER SUNSERI: Well, actually at least my thinking, I'm starting to come around to the staff's position on this a little bit. Let me summarize maybe what I'm thinking -- what I'm hearing that gives me more confidence.

First off, it's not a four-inch pipe that we're taking a section of. It may be a four-inch nozzle, but it's going to be reduced down to some limited size tubing and isolated from the rest of the CES system for this sampling part. That's one. And that makes me feel more comfortable.

Two, there are criteria, I think, representative -- having a system that is going to provide a representative sample at a 72-hour period, I think, is some bounding criteria that a designer would use to design the system.

I think having a sampling pump that's going to pull sample off and, you know, not have to rely on a differential pressure system to operate, which was not known to me, and now is, I think makes sense.

So, it's starting to look more like a traditional sampling system now than it did when I originally heard the idea.

So, you know, I'm not -- I mean, on the --

on a by-design sampling system you got to breach the containment as well to get the sample, right, but you have an isolation valve that you open and close.

So, that sounds like it's going to happen in this case, too. So, I guess I'm -- I guess, Anne-Marie, you've done a good job of alleviating some of my concerns about this system.

MS. GRADY: Thank you.

MEMBER REMPE: Thank you, Anne-Marie.

CHAIR KIRCHNER: With your indulgence, we'll go further into the hour, if that's alright.

MR. STUTZCAGE: Yeah. I only have a couple slides here to try to address some of the radiological concerns.

So, one of the questions that the ACRS asked about the dose to a worker going out to re-isolate the system -- and basically just this slide is we just -- there's too many unknowns for us to come up with the dose to the worker.

As we discussed, the dose values to the offsite and the main control room were, you know, based on varying parameters in the -- for flow rate in an ANSI standard and a maximum leak rate.

To share that, we don't know where the piping is, we don't know where the piping changes sizes, ventilation flow rates in the room, the volume of the room, et cetera, to be able to come up with a dose to an individual performing an action to re-isolate the system.

Next slide, please. So, as we discussed, as Anne-Marie said, the staff believes that the information obtained from monitoring is beneficial in assisting operators in making decisions following an accident.

Therefore, the staff believes that at this stage of the licensing the best path forward is to retain the rulemaking carve-out.

And as we discussed, the carve-out is on the radiological pieces, the regulation for considering leakage and the dose to offsite and members of the public. And for potential operator actions in the field, that regulation is also included.

So, one of the -- another potential solution, besides what was discussed earlier, was if the applicant was able to demonstrate the system could be re-isolated, that would, you know, relieve the concern of potentially un -- you know -- controllable release to the environment from opening the system. So, that's what the rulemaking carve-out tries to address.

Next slide, please. So, and here's some of the benefits of the rulemaking carve-out. Carve-outs are about a licensing tool that are used when appropriate.

The carve-out approach does not foreclose any future regulatory decisions or design changes for this issue, and it retains flexibility for staff and NuScale to continue to evaluate this issue while still providing finality on the large majority of the design.

And that, I think, concludes our presentation on hydrogen and oxygen monitoring.

DR. SCHULTZ: Ed, just to summarize, you mentioned the three different areas that you have concerns about.

You don't have enough information to be able to address those concerns --

MR. STUTZCAGE: Right. And that's why it's in the rulemaking carve-out for the co-op of the community to try to provide that information and one way or another address it.

DR. SCHULTZ: From an engineering sense, you believe that, you know, there ought to be a solution or at least you would be in a position to be able to analyze whether there, in fact, is a problem.

MR. STUTZCAGE: Right.

DR. SCHULTZ: The concern is that you haven't been able to address it.

MR. STUTZCAGE: Right. Right.

DR. SCHULTZ: Not that there is a concern that is --

MR. STUTZCAGE: I think that accurately describes it. Thank you.

MR. TESFAYE: Okay.

CHAIR KIRCHNER: Yes. Let's keep going because I know at least one person has to leave in a little bit. So, I'd prefer to continue.

MR. TESFAYE: Yeah. We should go faster. Okay. The next few slides will be presented by Raul.

MR. HERNANDEZ: Hi. Good afternoon. My name is Raul Hernandez. I was -- I was a reviewer for the - plant assistant for the spent fuel pool area -- spent fuel pool design and spent fuel pool cooling.

And in the letter that you guys provided, you mention that you wanted to talk about the resolution of open item 9.1.2-1.

The main concern with this open item was that the pool leakage detection system that was provided for the spent fuel pool and the ultimate heat sink, because there's just one combined pool, did not include leakage channels behind the welds of the walls. It did provide them on the floor of the pool.

The floor of the pool -- there's leakage channels not behind the main panels. We are -- because the panels are -- we're not expecting the panels to fail, but operational experience has shown that welding of stainless steel, usually you have some leakage through them. So, there is some leakage channel behind the welds of the panels.

And the applicant design did include leakage channels on the floor and the periphery of the pools, but they did not include any behind the walls.

So, the staff issued several RAIs. This was not an issue of only one branch. There were like four different branches.

And we did an audit with the applicant. And after discussing the result of the audit with the applicant, the applicant decided to add those leakage channels behind the walls of the pool.

The leakage detection system basically is just the channels behind the welds and it gets routed to the rad waste drain system.

The rad waste drain system includes monitoring for level and radiation and it will identify leakage, and that's where it gets identified basically.

You were asked -- one of the questions that you posed on the letter was about the identification on the alarms and they are part of the rad waste system.

MEMBER REMPE: So, is there anything special about the levels they selected? In your SE that you mentioned that they had alarms to go off at predetermined levels, was it just something they --

MR. HERNANDEZ: The alarms are not specifically for the leakage detection of the pool.

MEMBER REMPE: Uh-huh.

MR. HERNANDEZ: They are the alarms of the sumps of the rad waste system.

MEMBER REMPE: Okay.

MR. HERNANDEZ: During normal operation the rad waste systems isolate all the flow into it. So, any unidentified leakage would come from the pool leakage detection system.

MEMBER REMPE: Okay.

MR. HERNANDEZ: They have -- if the pumps actuate because of a level alarm, it will inform in the control room.

And if it actuates because of a high-high level alarm, because the rate of flow is too high, then it's alarmed locally in the control room and I think it's a waste management control room, too.

MEMBER REMPE: Okay. I just wanted to give a high level. I think some of these questions could have been resolved just from an informal communication.

And we might want to consider that in this process in the future because it was just -- didn't have enough information to do this on our own.

MR. TESFAYE: Yeah. We understand. I sort of mentioned that at the beginning of this presentation.

DR. SCHULTZ: Okay. These are monitors that have set points that alarm. We're not getting readings in each of these three locations, but we're getting alarms.

MR. HERNANDEZ: The reading is that the pumps were actuated, you know. The alarms for actuation of the pump is basically the pump -- the pumps were actuated.

But the flow when it gets transferred to the rad waste system, we get sample, we get -- it's treated through the -- like the normal rad waste.

DR. SCHULTZ: Okay. Fair enough. Thank

you.

MR. HERNANDEZ: Uh-huh. Okay. Now, the next slides is talking about the differences between the Phase 2 and Phase 4.

This is -- okay. None of them were related to a design change on the spent fuel pool cooler system. Those were mostly changes to the wording on the SE.

In this case, this is a concurrent change. As part of the Chapter 15 evaluation, one of the assumptions for the peak containment pressure was what is the initial temperature of the pool, because that determines the temperature of the containment walls, and the temperature was lowered from 140 to 110. So, the cooling system's maximum temperature limit was lowered from 140 to 110.

When the staff evaluated the design of the system as described in the DCA, the system is capable of maintaining the pool below a hundred degrees. So, changing the limit did not change the operation of the system at all.

Next. In this one, it's -- yeah, this could have been clarified at informal setting. The safety limit for the spent fuel pool has not been changed. It is 55 feet.

There is a discussion in Section 9.1.3 dealing with always maintaining -- well, not always. Provisions to keep at least ten feet of water above the stored fuel. And this is for radiation shielding -- to provide adequate radiation shielding.

The discussion about the safety limit is the amount of water needed to maintain the fuel cooler for a longer period of time to provide cooling, and the applicant identified this level as 55 feet.

The safety evaluation of the spent fuel is discussed in Section 9.2.5, which is the ultimate heat sink, because the spent fuel pool and the ultimate heat sink is just one body of water.

So, when we did the thermal evaluation for the system, there was no way to isolate one heat source from the other. So, we just combined one thermal evaluation in Section 9.2.5.

Next. This is -- in the Phase 2 we were -- okay. The ultimate heat sink is designed to maintain sufficient inventory of cooling water. So, should -- no makeup is needed for 30 days, but Phase 2 stated that no makeup is needed for several weeks.

Once -- this change was due -- was performed to maintain consistency between the two sections. We already reach a conclusion that the design has sufficient water for at least 30 days.

So, it's better to be consistent through all this, so we made the changes accordingly in this section.

This change is reference items. In the Phase 4 SE we made reference to the DSRS. In Phase 2 we made reference to the SRP.

During the final review process, the applicant in Section 1 -- in Chapter 1 the applicant made clear that they are in conformance with the DSRS. So, the staff revised our SE to be consistent with this.

There is no significant changes between the requirements of the DSRS and the SRP. They are basically equivalent.

The DSRS was modified to account for more than one core. So, they changed the reference to rated thermal power to account for all the cores, which the SRP is only focusing on one.

MR. TESFAYE: Thank you.

MR. HERNANDEZ: That was my last slide.

MR. TESFAYE: The next slide will be presented by Chang Li.

MR. LI: There is also -- the difference that's in Phase 2 SER -- between the Phase 2 SER and the Phase 4 SER that shows some questions.

The chilled water systems provides the cooling function for the heating and the ventilation systems.

The SRP Section 9.2.7 provides guidance to review the systems. So, in Phase 2 SER it's concluded that this systems conforms to GDC 44.

GDC 44 is about cooling systems -- cooling requirements that -- and later I think in a concurrent process, the OGC pointed out actually in Chapter 3, there is a section 3.1.4.15 discussing about the conformance of all different GDCs.

And NuScale indicates that they do not conform with GDC. Instead, they conform with their design-specific PDC 44 for the cooling systems.

The PDC 44 systems, which I stated earlier, I don't want to read it, is similar for 44 with the exception that they take care of the safety related systems that the cooling is discharged to -- being removed from the ultimate heat sink instead of GDC 44 says the cooling is removed by the other cooling system such as service water systems.

So, in that case, the review of the systems, the chilled water system is non-safety systems. It's not important to safety systems.

So, if -- when we read that PDC 44, actually all those provisions talking about ultimate heat sink, talking about this redundancy review, interconnections to leak detections, isolation capabilities and single failures, so forth, are not -- this provisions are not applicable for the chilled water systems because they are non-safety.

So, the wording that's been revised to state now says the chilled water systems are reviewed against the PDC 44, and the provisions in that PDC 44 does not apply to the systems.

So, that's -- actually there is no change in terms of the systems.

MR. TESFAYE: Okay. Thank you.

Okay. So, the last couple of slides since, you know, at the beginning of this presentation I mentioned that we didn't discuss open items, how we close them, I want to make sure that we have addressed all the open items for Chapter 9 in this presentation.

So, the remaining open items -- there were a couple of open items Section 9.1.1. Both of them related to information that we didn't have. They were both addressed by COL items in this section. And the staff has evaluated the COL items, and they found them to be acceptable.

The next one is -- in Section 9.3.2 there were several open items specifically related to either exemption request for process sampling system or the AST topical report methodology.

Those were completed with our Phase 4. So, all these items were closed. So, the issuance of the SER for the AST and the approval of the exemption request in Chapter 9.

And the last open item deals with lighting system. There is a typo here. It says, this exemption of course is tied -- it should have said, this open item is tied to the completion of the exemption request for GDC 17 and conformance to Reg Guide 1.75.

Both those things have been addressed in Section 8.3.1 of the SER. So, this open item is closed.

So, all the open items have been closed. And because of our new approach, this streamlined approach, we don't discuss how we close these open items in the ACR. We don't even discuss confirmatory items in the SER.

We just leave them as bubbles in the Word document so we can just -- once they are confirmed, we can drop them and issue the final SER.

So, this is a new way of doing business now. So, we've learned something from this and we will improve on the process for the next one.

MEMBER REMPE: Again, I didn't -- when we brought this up and discussed it in full committee, I mentioned I don't think any of these things are risk significant, but I don't have the knowledge to say let's not bother anymore.

So, an informal meeting -- and I think I even had a caveat, is there anything risk significant? And I think you said at the beginning of this presentation there were on changes to the systems, et cetera. There was a lot of just conforming with minor corrections or whatever.

So, that helps, but maybe we could have done this without having the whole committee listening to it or the whole subcommittee listening to it.

MR. TESFAYE: Thank you.

CHAIR KIRCHNER: Thank you, Getachew.

Members, any further questions of the staff? No?

This is an open meeting, so I'm going to turn next to the public and see if there's anyone in the audience who wishes to make a comment.

Please step forward to a microphone,

identify yourself and make your comment.

(Pause.)

CHAIR KIRCHNER: Seeing no one, the next -- we need to open -- the bridge line is open. Okay. If there is anyone out on the public line who wishes to make a comment, would you state your name and please make your comment?

MS. FIELDS: Yes. This is Sarah Fields.

I'd like to go back to the discussion of Thelma and Louise and certain considerations related to that movie.

That movie was filmed in Moab, Utah, and where you'd see in part of the movie them driving around seemingly going someplace, but they're really just driving around in Arches National Park.

In Moab, we have a very well-developed emergency response program for people who go off cliffs. And people go off cliffs.

So, emergency response to any accidents is very well-developed in this community. And that, of course, is relevant to your discussion today and to the whole review particularly when the NRC and industry would like to limit emergency response programs for small modular and advanced reactors.

Another consideration related to Thelma

and Louse is when they exited Arches National Park, they went about going down -- turning left, going downhill about a half a mile you have the Atlas uranium mill tailings pile.

And that now is a $1 billion taxpayer-funded mill tailings removal project. And that happened because of over 30 years of Nuclear Regulatory Commission mismanagement of the mill tailings.

There were egregious errors on the part of the Nuclear Regulatory Commission, and that is why taxpayers are paying for the removal of these tailings that were produced by a commercial entity, and this has affected our community.

So, wherever you have a nuclear installation regulated by the NRC, whether it's a mill tailings, a uranium mill or a new nuclear designed operation such as NuScale SMR, it impacts the community.

And when things go wrong, it's the community, it's the workers, it's the taxpayers, it's the rate payers who will be impacted, and I think that both the NRC and the ACRS should put all this into a larger context.

Particularly a context where, as with the

Moab uranium mill tailing site, the NRC never went back and produced a document that outlines all their egregious errors from suppressing documents, from not only having a fraction of the surety that was required to remediate the tailings and site.

And that's why Congress took over and gave it to the DOE for -- and eventually a decision was made to take those tailings off the floodplain of the Colorado River while the NRC wanted to just leave them there.

So, you have community issues that should be taken into consideration. And when things go wrong, it's up to the NRC to assure that there will be documentation of what went wrong.

So, as -- if and when a NuScale 12-module reactor is constructed and operation commences, I would expect the NRC will make sure that whatever assumptions they originally made were the correct assumptions.

Then if even small things go wrong or are not in keeping with the original expectations, that there will be a complete review of -- and a complete public review of what exactly is happening and what NRC decisions were correct or incorrect as this facility moves forward. Thank you.

CHAIR KIRCHNER: Thank you, Ms. Fields.

Any other members of the public wishing to make a comment, please do so.

(Pause.)

CHAIR KIRCHNER: Okay. Hearing none, at this point I think we can adjourn our meeting. Thank you all.

(Whereupon, at 12:35 p.m. the meeting was adjourned.)

February 28, 2020 Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Submittal of Presentation Materials Entitled "ACRS Subcommittee Presentation: NuScale FSAR – Chapter 20," PM-0220-69058, 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) NuScale Subcommittee Meeting on March 4, 2020. The materials support NuScale's presentation of NuScale FSAR Chapter 20.

The enclosure to this letter is the nonproprietary presentation entitled "ACRS Subcommittee Presentation: NuScale FSAR – Chapter 20," PM-0220-69058, Revision 0

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

If you have any questions, please contact Jim Osborn at 541-360-0693 or at josborn@nuscalepower.com.

Sincerely,

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

Distribution: Robert Taylor, NRC, OWFN-8H12
Michael Snodderly, NRC, OWFN-8H12
Christopher Brown, NRC, OWFN-8H12
Gregory Cranston, NRC, OWFN-8H12
Michael Dudek, NRC, OWFN-8H12
Omid Tabatabai, NRC, OWFN-8H12

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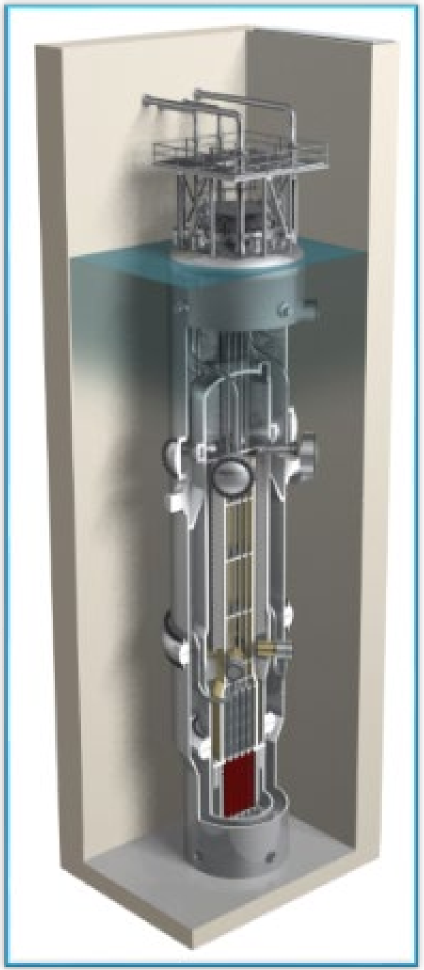
ACRS Subcommittee Presentation



NuScale DCA

FSAR Chapter 20

March 4, 2020

PM-0220-69058
Revision:

Presenters

Jim Osborn

Licensing Engineer

Chris Maxwell

Senior Reactor Operator

DCA Chapter 20 Changes

- The DCA text was revised in Section 20.1.3 to include pointers to Tables 20.1-1, 20.1-2 and 20.1-3
- Footnotes were added to Tables 20.1-1, 20.1-2 and 20.1-3 to clarify that monitoring is not relied upon for the mitigation strategies and guidelines
  - Footnote states, “Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 72 hours of module monitoring and at least 14 days of UHS monitoring as a supplementary capability.”

DCA Section 20.1.3 Changes

Monitoring

- No operator action is required to establish or maintain the required safety functions for at least 50 days following the onset of a loss of all AC power. Therefore, no instrumentation is necessary to support operator actions.
- Although not necessary because of the fail-safe and passive design, monitoring instrumentation (safety display and indication system, SDIS) is maintained in the main control room for at least 72 hours to provide additional assurance that systems have responded as designed (see Table 20.1-1 and Table 20.1-2).
- Although sufficient UHS level exists for at least 50 days, UHS level monitoring, which includes SFP level, is assured for at least 14 days using installed equipment and dedicated backup battery power supplies~~y~~ (see Table 20.1-3).

The installed equipment relied on to ensure core cooling, containment, and SFP cooling is safety-related and has sufficient capacity and capability to perform those functions for at least 50 days. Beyond the installed-equipment coping duration, only a small amount of water (approximately 28 gpm) added through a gravity-fed piping system would maintain the remaining pool inventory. Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 72 hours of module and at least 14 days of UHS monitoring as a supplementary capability. Therefore, the installed-equipment coping capability provides adequate time to obtain offsite assistance and resources, if needed and no preplanned offsite resources are required for a NuScale Power Plant to respond to a loss of all AC power event.

DCA Table 20.1-1 Changes

Table 20.1-1: Core Cooling Parameters(1)

Function	Parameters for Assuring Function is Established	Parameters for Assuring Function is Maintained
RCS inventory control	RPV water level	None(21)
	Containment isolation valve positions	
Reactivity control	Neutron flux	None(21)
	Core inlet temperature	
	Core exit temperature	
	Reactor trip breaker status	
	CVCS containment isolation valve positions	
DHRS decay heat removal	Core exit temperature	Spent fuel pool level(32)
	DHRS valve positions	
	MSIV positions	
	MSIV bypass isolation valve positions	
	FWIV positions	
	Spent fuel pool level(32)	
ECCS decay heat removal	ECCS valve positions	Spent fuel pool level(32)
	Containment water level	
	RPV water level	
	Core exit temperature	
	Spent fuel pool level(32)	

(1) Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 72 hours of module monitoring, and at least 14 days of UHS monitoring as a supplementary capability.

(21) By design, once these functions are established, they are maintained indefinitely.

(32) Spent fuel pool level provides indication of UHS level when UHS level is above the SFP weir.

DCA Table 20.1-2 & -3 Changes

Table 20.1-2: Containment Parameters(1)

Function	Parameters for Assuring Function is Established	Parameters for Assuring Function is Maintained
Containment isolation	Containment isolation valve positions	None(2~~1~~)
Containment heat removal	Wide range containment pressure	Spent fuel pool level(3~~2~~)
	Spent fuel pool level(3~~2~~)	

(1) Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 72 hours of module monitoring, and at least 14 days of UHS monitoring as a supplementary capability.

(2~~1~~) By design, once these functions are established, they are maintained indefinitely.

(3~~2~~) Spent fuel pool level provides indication of UHS level when UHS level is above the SFP weir.

Table 20.1-3: Spent Fuel Pool Parameters(1)

Function	Parameter for Assuring Function is Established	Parameter for Assuring Function is Maintained
Spent Fuel Pool Cooling	Spent fuel pool level	Spent fuel pool level

(1) Monitoring is not relied on for the mitigation strategies and guidelines, but installed instrumentation provides at least 14 days of UHS monitoring as a supplementary capability.

Acronyms

AC	Alternating Current
SFP	Spent Fuel Pool
UHS	Ultimate Heat Sink

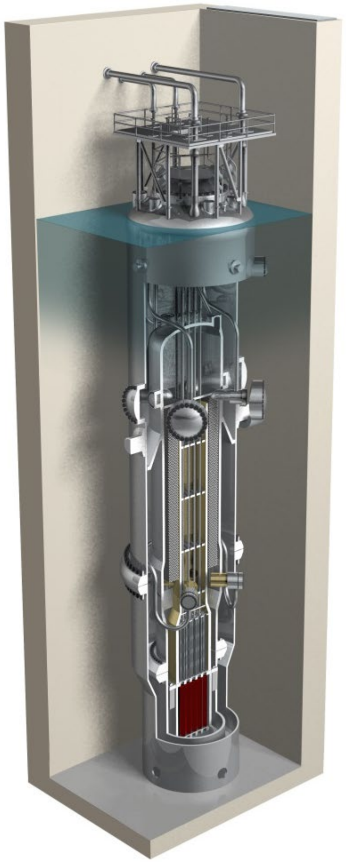
Portland Office
6650 SW Redwood Lane,
Suite 210
Portland, OR 97224
971.371.1592

Corvallis Office
1100 NE Circle Blvd., Suite 200
Corvallis, OR 97330
541.360.0500

Rockville Office
11333 Woodglen Ave., Suite 205
Rockville, MD 20852
301.770.0472

Richland Office
1933 Jadwin Ave., Suite 130
Richland, WA 99354
541.360.0500

Charlotte Office
2815 Coliseum Centre Drive,
Suite 230
Charlotte, NC 28217
980.349.4804



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Twitter: @NuScale_Power

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March 3, 2020 Docket No. 52-048

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ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Submittal of Presentation Materials Entitled "ACRS Subcommittee Presentation: NuScale Topic – Hydrogen Monitoring," PM-0220-69071, 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) NuScale Subcommittee Meeting on March 4, 2020. The materials support NuScale's presentation of hydrogen monitoring.

The enclosure to this letter is the nonproprietary presentation "ACRS Subcommittee Presentation: NuScale Topic – Hydrogen Monitoring," PM-0220-69071, Revision 0.

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

If you have any questions, please contact Matthew Presson at 541-452-7531 or at mpresson@nuscalepower.com.

Sincerely,

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

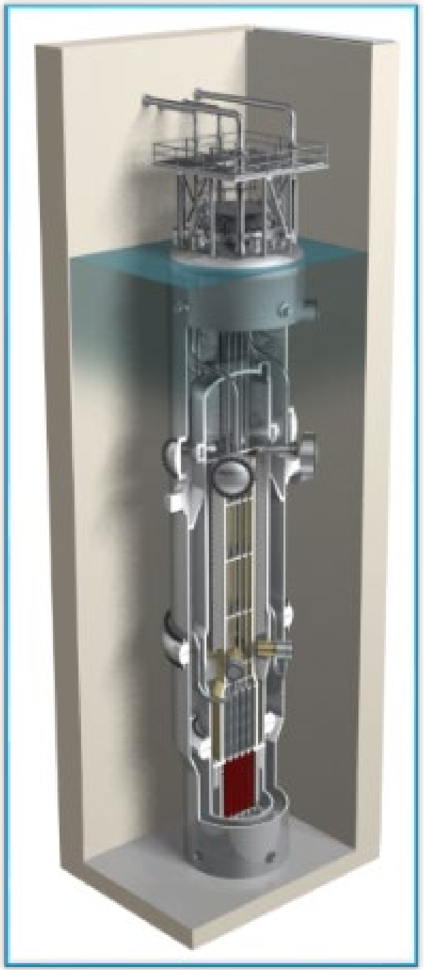
Distribution: Robert Taylor, NRC, OWFN-8H12
Michael Snodderly, NRC, OWFN-8H12
Christopher Brown, NRC, OWFN-8H12
Gregory Cranston, NRC, OWFN-8H12
Michael Dudek, NRC, OWFN-8H12
Getachew Tesfaye, NRC, OEFN-8H12

Enclosure: "ACRS Subcommittee Presentation: NuScale FSAR Topic – Hydrogen Monitoring," PM-0220-69071, Revision 0

Enclosure:

"ACRS Subcommittee Presentation: NuScale Topic – Hydrogen Monitoring," PM-0220-69071, Revision 0

ACRS Subcommittee Presentation



NuScale Topic
Hydrogen Monitoring

March 4, 2020

Presenters

Matthew Presson

Licensing Project Manager

Jim Osborn

Licensing Engineer

Introduction

- Design Basis vs. Beyond Design Basis
- Timing of Detrimental Combustible Mixture
- Operational Decisions for Hydrogen (H2) Monitoring
- Radiation Protection Issue
- Equipment Capability to Withstand Combustion Events
- Containment Mixing and Sampling

Design Basis vs. Beyond Design Basis

- The NuScale facility was designed using a framework of Design Basis and Beyond Design Basis categories for accident mitigation:
- Design Basis Accident (DBA)
  – A postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components (SSCs) necessary to ensure public health and safety.
- Beyond Design Basis Accident (BDBA)
  – This term is used as a technical way to discuss accident sequences that are possible but were not fully considered in the design process because they were judged to be too unlikely. In that sense, they are considered beyond the scope of design-basis accidents that a nuclear facility must be designed and built to withstand.

  – As the regulatory process strives to be as thorough as possible, “beyond design-basis” accident sequences are analyzed to fully understand the capability of a design.

Design Basis vs. Beyond Design Basis

- Design Basis Accident (DBA)
  - If an SSC is relied upon to remain functional (to meet regulatory criteria) during and following a DBA, then the SSC must be categorized as (as appropriate):
    - Single Failure Proof
    - Safety-Related
    - Seismic Category 1
    - 1E Power
  - If an SSC is not categorized as such, it cannot be relied upon for accident mitigation
  - Therefore, the safety analysis of an DBA can only credit SSCs that are appropriately categorized, as above
  - SSCs that are categorized in a lesser category cannot be credited in accident analyses
    - Example: Typical Chapter 15 accidents

Design Basis vs. Beyond Design Basis

- Beyond Design Basis Accident (BDBA)
  - Because BDBAs are considered more unlikely than DBAs, nonsafety-related SSCs can be credited for accident mitigation
    - Example: ATWS (10CFR50.62) and SBO (10CFR50.63) allow the use of nonsafety-related equipment for accident mitigation
    - Often include multiple failures beyond those considered for DBEs, and thus more realistic assumptions are allowed in the analyses
  - This is also why 10 CFR 50.44 was revised by the NRC (in 2003) to allow the hydrogen monitoring system to be nonsafety-related, therefore not single failure proof, not seismic category 1, and no 1E power source
  - Therefore, the NuScale hydrogen monitoring system is not safety-related, not single failure proof, not seismic category 1, and does not have 1E power, because it is used only for beyond design basis accidents

Timing of Detrimental Mixture

- A detrimental mixture is a combustible mixture which can threaten containment integrity
- Analysis shows there is a minimum of 72 hours before a detrimental mixture can be developed
- 100% core damage is not the most limiting scenario relative to time
- 72 hours is NuScale's design basis passive coping period
  - "…after 72 hours, the applicant states that this represents a reasonable period of time to implement severe accident management guidelines to mitigate the accumulation of combustible gases. This time period aligns with that used in current regulatory precedent and is therefore acceptable." Chapter 6 SER, Section 6.2.5.4
- Exemption from 10CFR50.44(c)(4) is not recommended

Operational Decisions for H2 Monitoring

- Analyses show there is at least 72 hours before a combustible mixture could threaten containment
  - Therefore, the plant personnel have time to weigh options and inspect systems before use
- Reg Guide 1.7 provides a risk-informed decision process
  - Appropriate priority with other activities
  - Need for the information by decision-makers
  - Insights from experience or evaluation
- Therefore, in the unlikely use of the H2 monitoring system, evaluations and inspections can occur

Radiation Protection Issue

- The system is unlikely to leak because:
  - Included in the Leakage Control Program
  - Used during normal operations
  - Operators have sufficient time to inspect system prior to use
- If the H2 monitoring system leaks during its use, operators could isolate and repair the leak
- The ERO to develop ad hoc, unplanned operator actions performed under 10 CFR 50.47(b)(11)
- NRC Staff states that the DCA scope of design does not provide enough information to perform this dose analysis
- Staff position is that this will be carved out of the rule to be resolved at a future time

Equipment Capability to Withstand Combustion

- The containment can withstand any combustion event for the first 72 hours
- Per FSAR Table 3.2-1, the pressure boundary of monitoring path can withstand combustion events, like the containment
- NuScale and NRC Staff agree that this design capability is provided for the monitoring pathway

Containment Mixing and Sampling

- ANSI N13.1-2011 requires sampling be representative
- Regulations [10 CFR 50.44(c)(1)] require that containments ensure a mixed atmosphere during design basis and beyond design basis accidents
- Mixing described in FSAR Section 6.2.5 and RAI 8862 response
- Analysis shows that containment is well-mixed, even neglecting ECCS flow, with plant conditions stable
- NuScale and NRC Staff are in agreement regarding compliance with 10 CFR 50.44(c)(1).
  - "Given the large margin between the calculated Ra and conditions indicative of turbulence, the staff finds it reasonable to conclude that the entirety of containment will be mixed (even before considering the effect of additional flow stimulated by steam flow from the RVVs and condensation on the walls)." –Chapter 6 SER, Section 6.2.5.4

Summary and Conclusions

- Core melt accident is a beyond design basis accident
  - Consistent with industry practice, allows nonsafety-related SSCs
  - The low frequency of a NuScale core melt accident makes it hard to see how it can be considered credible
- Bounding analyses shows there is a minimum of 72 hours before containment can be threatened
- Decision to place system into service would follow RG 1.7 risk-informed process and appropriate precautions
  - There is sufficient time to inspect and evaluate system condition
  - If excessive leaks develop, can isolate and repair
- Monitoring path can withstand combustion events
- Containment is well-mixed and representative sampling is required

Acronyms

ATWS	Anticipated Transient Without SCRAM
BDBA	Beyond Design Basis Accident
CES	Containment Evacuation System
CNV	Containment Vessel
DBA	Design Basis Accident
FCI	Fuel-Coolant Interaction
FR	Federal Register
GDC	General Design Criteria
Mcyr	module critical year
ms	milli-second
SBO	Station Blackout
SER	Safety Evaluation Report
SRM	Staff Requirements Memo
SSC	Structure, System, or Component
TMI	Three Mile Island

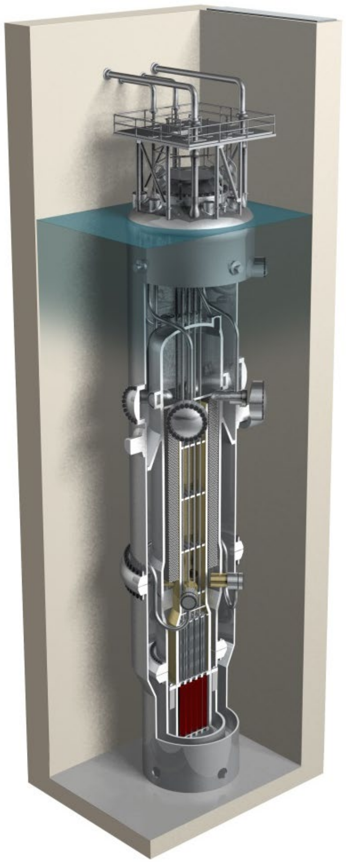
Portland Office
6650 SW Redwood Lane,
Suite 210
Portland, OR 97224
971.371.1592

Corvallis Office
1100 NE Circle Blvd., Suite 200
Corvallis, OR 97330
541.360.0500

Rockville Office
11333 Woodglen Ave., Suite 205
Rockville, MD 20852
301.770.0472

Richland Office
1933 Jadwin Ave., Suite 130
Richland, WA 99354
541.360.0500

Charlotte Office
2815 Coliseum Centre Drive,
Suite 230
Charlotte, NC 28217
980.349.4804



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Backup Slides

Containment Isolation Failure

- Chapter 19 documents an assessment of whether a severe core damage event, with a steam explosion that results in containment failure (e.g., CES containment isolation failure) could lead to a large release (NUREG-0396)
- The conclusion is that "at the earliest possible time of fuel-coolant interaction (FCI), the airborne fraction of volatile fission product aerosols is less than the calculated threshold for a large release."
  - 6.8 hours is the earliest possible time of FCI for intact containment accidents

Containment Isolation Failure

- If containment is unisolated for the purpose of combustible gas monitoring resulting in a leak, this would be a similar situation, except that it would be expected to occur at a later time, potentially as late as 72 hours
  - This would result in additional containment aerosol deposition
  - The release would not be directly to the atmosphere
- Therefore, under the bounding assumption that the CES piping were to be completely sheared at the time isolation, it is reasonable to conclude this would not result in a large release or threaten public safety

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Presentation to the ACRS Subcommittee

NuScale Power, LLC (NuScale)

Design Certification Application Review

Safety Evaluation with No Open Items:
Chapter 9, "Auxiliary Systems"
And Related Topics

March 4, 2020

Technical Reviewers:

Anne-Marie Grady, NRR/DRA/APLC
Michelle Hart, NRR/DANU/UART
Tony Nakanishi, NRR/DRA/APLA
Alexandra Siwy - NRR/DSS/SNRB
Alissa Neuhausen - NRR/DRA/APLC
Ryan Nolan - NRR/DSS/SNRB
Raul Hernandez - NRR/DSS/SCPB
Hanry Wagage - NRR/DSS/SCPB
Chang Li - NRR/DSS/SCPB
Angelo Stubbs - NRR/DSS/SCPB
Bob Vettori - NRR/DRA/APLAB
Edward Stutzcage – NRR/DRA/ARCB
Tony Gardner - NRR/DNRL/NCSG
Alexander Chereskin - NRR/DNRL/NCSG
Fanta Sacko - NRR/DEX/EENB
Andrew Yeshnik - NRR/DANU/UART
Nan Chien – NRR/DSS/SCPB
Dawnmathews Kalathiveettil - NRR/DEX/EICA

Project Managers:

Greg Cranston – Lead Project Manager
Getachew Tesfaye – Chapter Project Manager

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Status of H_2 and O_2 Post-accident Monitoring in Containment

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- H_2 and O_2 post-accident monitoring is used to measure the gas concentrations in the CNV to identify flammable conditions early enough to prevent a deflagration to detonation transition (DDT) event.
- The NuScale CNV integrity post severe accident following a DDT event has been analyzed to be maintained for 72 hours.
- Radiolysis which produces both H_2 and O_2 continues for weeks after a severe accident and could lead to a potential DDT threat at or about 45 days.
- Exemption Request #2 staff finding credits H_2 and O_2 post-accident monitoring for mitigation actions.
- Exemption Request #16, (PASS) staff finding credits the capability to monitor H_2 and O_2 concentrations as required by 10 CFR 50.44(c)(4)

Focus Area - ACRS AST letter

Need for long-term post-accident H_2 and O_2 monitoring.

To inform the timing of the following actions:

- Inert the containment atmosphere with nitrogen via CVCS and DNS

  or

- Vent the containment during accident conditions (i.e., routing the gas either to the plant exhaust stack (RBVS) or to the gaseous radwaste system (GRWS).

  and

- Confirm success of above mitigating actions

Inform the actions in the EOP and the severe accident management guidelines (SAMG)

ACRS AST letter and related topics

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Need for long-term post-accident H_2 and O_2 monitoring.

By informing the timing of operator action, **avoiding**:

Risking an impulse pressure to the inside of the CNV, which, at 45 days:

- would be approximately double the impulse pressure at 72 hrs, and
- could lead to CRDM access flange (CNV25) bolt load exceeding the ASME Service Level D strain limits

Risking an uncontrolled release to the public.

Focus Area - ACRS AST letter

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Capability of the design for accurate long-term post-accident H_2 and O_2 monitoring.

The H_2 and O_2 monitoring closed loop flowpath is established by:

- Confirming CNV pressure is < 250 psig (design pressure of CES, PSS, and CFDS)
- Unisolating the CES and the CFDS CIVs
- Creating a flow path from the CNV via CES through the PSS sample pump and in-line gas monitors, and returning to the CNV via CFDS.

This flowpath, except for the CIVs, is non-safety related, as is acceptable for equipment specifically used for mitigating a severe accident, per SECY-90-016, Equipment survivability.

Focus Area - ACRS AST letter

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Capability of the design for accurate long-term post-accident H_2 and O_2 monitoring.

In SER P4, chapter 6, staff concludes that the entirety of containment, both in the annular region and dome, would be mixed at 72 hrs post-accident.

NuScale asserts that post 72 hrs:

- convective mixing is driven by decay heat, and
- there are no sub-compartments to impede mixing

If non-condensables rise to CNMV dome without mixing, conservative O_2 and H_2 concentration readings would result.

Focus Area - ACRS AST letter

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ACRS comments about the rationale for long-term post-accident H_2 and O_2 monitoring.

In the December 20, 2019, ACRS letter (Item b):

- Weeks are available before monitoring information is needed to inform mitigating actions.

Staff elaboration:

- Combustible mixtures (5% O_2) would occur by 45 days post-accident
- The minimum concentration (4% O_2) would occur by 30 days
- Prior to reaching combustible mixtures (O_2 > 3%) would occur in 15 days

Staff conclusion:

- Start monitoring as early as 72 hours, and no later than 15 days.

Focus Area - ACRS AST letter

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ACRS comments about the rationale for long-term post-accident H_2 and O_2 monitoring.

In the December 20, 2019, ACRS letter (Item d):

- other pressure, temperature and radiation sensors available to follow severe accident progression

Staff clarification per the NuScale equipment survivability design:

Component/variable	Duration of qualification
Wide Range Containment Pressure	Until core damage
Narrow Range Containment Pressure	1 hour after transient
Under the Bioshield Temperature	1 hour after transient
Under the Bioshield Radiation Monitor	24 hours after core damage

None of these components indicate potential for combustion of gases.

Focus Area - ACRS AST letter

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ACRS comments about alternatives to long-term post-accident H_2 and O_2 monitoring that don't unisolate the containment

The options for actions which prevent combustible/detonable conditions in containment all include reopening isolation valves:

- Inerting by injecting N_2 into the containment via the CVCS

  or
- Venting the containment by using the CES system and directing the gas to the RBVS stack or the GRWS

No alternatives have been provided or identified by NuScale which would provide the concentration in containment of the combustibles, H_2 and O_2 without unisolating the CNV.

Focus Area Topics

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PSS post-accident monitoring of O_2 and H_2 risk evaluation

Operator action to prevent H_2 combustion →DDT	Time for operator action	H_2O_2 monitoring path isolable?	Prevent DDT pressure pulse	Result
vent CNV via CES+RBVS	3days< t <15 days	yes	yes	Opening CNV will not lead to large release
inert CNV via CVCS+DNS	3days< t <15 days	yes	yes	Opening CNV will not lead to large release
take no action	N/A	N/A	no	potential failure of CRDM access flange bolts after 15 days

Focus Area - ACRS AST letter

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Dose to an Individual Re-Isolating the Combustible Gas Monitoring System:

- The staff does not currently have enough information from NuScale such as system flow rate, system leakage rate, ventilation flow rate, room volumes, the specifics of the piping and equipment, etc., to be able to estimate the dose to an individual performing actions to re-isolate the systems.

Focus Area - ACRS AST letter

Rulemaking Carveout for Leakage Associated with H2/O2 Monitoring:

- The staff believes that the information obtained from monitoring is beneficial in assisting operators in making decisions following an accident.
- Therefore, the staff believes that at this stage of licensing the best path forward is to retain the rulemaking carveout.

Focus Area - ACRS AST letter

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Rulemaking Carveout for Leakage Associated with H2/O2 Monitoring:

Benefits:

- Carveouts are a valid licensing tool that are used when appropriate,
- The carveout approach does not foreclose any future regulatory decisions or design changes for this issue, and
- Retains flexibility for staff and NuScale to continue to evaluate this issue while still providing finality on the large majority of the design.

Pool Leakage Detection System (PLDS)

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Open Item 9.1.2-1

- **Concern :** The staff identified that the PLDS did not include leakage channels behind the pool walls, the staff requested the applicant to modify the design of the PLDS accordingly, or to justify how the proposed design meets its intended function.

- **Resolution:** After several RAI responses and a Staff audit, the applicant modified the PLDS to include leakage channels behind the UHS pool wall liner.

The PLDS functions in conjunction with the RWDS equipment drain subsystem. The PLDS directs liner leakage into the RWDS sumps. These sumps are monitored for sump levels, temperatures and radiation. Alarms are monitored locally, in the main control room, and the waste management control room.

Pool Bulk Temperature

Phase 4 SER Section 9.1.3.4.4 states that the pool cooling systems are designed to maintain the pool bulk temperature below 110°F. The Phase 2 SER had a temperature of 140°F.

- As a result of the revision of the containment peak pressure analysis discussed in Chapter 15, the applicant reduced the maximum initial reactor pool temperature from 140°F to 110°F.
- Revision 3 of the NuScale DCA revised the temperature limit for the pool cooling systems in Section 9.1.3.
- The change in operational limits is bounded by the thermal analysis performed at 140°F and evaluated in Section 9.2.5.

UHS Minimum Safe Water Level and Makeup Water

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Section 9.1.3.4.4 of the Phase 4 SER indicates that the minimum safe water level for the UHS (with respect to ECCS operation) is 55 ft from the floor of the pool. The Phase 2 SER stated that this minimum height was 3 meters above the top of fuel.

- This does not represent a change in the system design.
- The minimum safety water level (assumed in the thermal calculations) **remains unchanged** at 55 feet from the bottom of the pool. Section 9.1.3.4.1 of the Phase 2 SER indicated this.
- The minimum coverage of 10 ft (3 m) is to ensure adequate radiation shielding for the operator on the pool deck.

UHS Minimum Safe Water Level and Makeup Water

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Section 9.1.3.4.4 states that the UHS is designed to maintain sufficient inventory of cooling water, such that no makeup water is needed for at least 30 days. The Phase 2 SER states "..such that no makeup water is needed for several weeks."

- Section 9.2.5 of this SE concluded that UHS maintains sufficient inventory such that no makeup water is needed to fulfill its intended functions for at least 30 days.
- This change maintains consistency between the two SE Sections.

DSRS Section 9.1.3.III.3.D vs SRP Section 9.1.3.III.1.D

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The Phase 4 SER stated that the DSRS Section 9.1.3.III.3.D recommends that the cooling system should retain at least half of its full heat removal capacity assuming a single active failure. The Phase 2 SER stated that the SRP Section 9.1.3.III.1.D recommends that the minimum heat removal capacity of the forced-circulation cooling system be greater than 0.3 percent of the reactor rated thermal power.

- This does not represent a change in the system design, DCA Chapter 1 indicates that the applicant is in compliance with DSRS, the SE was revised to more accurately reflect the regulatory basis.
- Section 9.1.3.4.4 (page 32) addresses the systems capability to handle 0.3 percent of the total plant thermal output.

Chilled Water System (CHWS) and GDC 44 /PDC 44 Requirements

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The discussion about the ability of CHWS to meet GDC 44 /PDC 44 differs significantly in the Phase 4 and Phase 2 SERs.

- The CHWS provides cooling for the heating and ventilation systems. SRP Section 9.2.7 provides guidance for the CHWS for the conformance of GDC 44 on the cooling water function. In Phase 2 SER, the staff concluded that the CHWS complied with the requirements of the GDC 44.
- NuScale cooling water system is committed to conforming to PDC 44, instead of GDC 44.
- NuScale PDC 44:

  A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that the system safety function can be accomplished, assuming a single failure.

- In the NuScale passive design, the CHWS does not support any safety-related SSCs under normal and accident conditions. Therefore, in Phase 4 SER, the staff determined the provisions of PDC 44 do not apply to this system.

Other Phase 3 Open items

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9.1.1 - Criticality Safety of New and Spent Fuel Storage

- Open Item 9.1.1-1: Because the applicant did not specify a neutron absorbing material, the staff requested additional details on manufacturing and materials qualification
  - The applicant added COL Item 9.1-9, which will demonstrate that the selected material and the as-manufactured neutron absorber products meet the acceptance criteria in the criticality and materials analyses
- Open Item 9.1.1-2: The applicant indicated its intent to make the structural analysis of the spent fuel racks a COL item
  - The applicant added COL Item 9.1-8, which will provide a structural evaluation and confirm that thermal-hydraulic, criticality, and material analysis aspects remain valid
- The staff reviewed the COL items and finds them acceptable.

Other Phase 3 Open items

9.3.2 Process and Post-accident Sampling Systems

- Open Items 9.3.2-1, 2, 3, 4, 5, 6, and 8.

  These seven open items were tied to the completion of the exemption request for post-accident sampling requirement and the accident source term (AST) topical report.

  These open items were addressed with the exemption request approval in Section 9.3.2 of the staff's SER and the SER for the AST topical report.

9.5.3 Lighting Systems

- Open Item 9.5.3-1

  This exemption request is tied to the completion of the exemption request for GDC 17 and conformance to RG 1.75. The applicant stated that the guidance in RG 1.75 regarding physical separation between lighting circuits that are not safety-related and safety-related circuits is not applicable because all onsite AC power systems are not safety-related and non-Class 1E.

  This open item is addressed by exemption from GDC 17 and evaluation of RG 1.75 in Section 8.3.1 of the SER.

Abbreviations

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AST	accident source term
CDE	core damage event
CDST	core damage source term
CES	containment evacuation system
CFDS	containment flooding and drain system
CNV	containment vessel
COL	combined operating license
CRHS	control room habitability system
CRVS	normal control room HVAC system
CVCS	chemical and volume control system
EOP	emergency operating procedures
DBST	design basis source term
DCA	design certification application
DF	decontamination factor
EQ	environmental qualification
ES	equipment survivability
FHA	fuel handing accident
HVAC	heating ventilation and air conditioning
PSS	process sampling system
PWR	pressurized water reactor
RBVS	reactor building ventilation system
REA	rod ejection accident
rem	Roentgen equivalent man
RG	regulatory guide
RRV	reactor recirculation valve
RVV	reactor vent valve
SA	severe accident
SAMG	severe accident management guidelines
SECY	Commission paper
SGTF	steam generator tube failure
SMR	small modular reactor
SSCs	structures, systems and components
TEDE	total effective dose equivalent
TR	topical report