Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards Open Session
Docket Number:	(n/a)
Location:	teleconference
Date:	Wednesday, June 3, 2020

Work Order No.: NRC-0918 Pages 1-207

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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674TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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OPEN SESSION

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WEDNESDAY, JUNE 3, 2020

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

COMMITTEE MEMBERS:

MATTHEW W. SUNSERI, Chairman

JOY L. REMPE, Vice Chairman

WALTER L. KIRCHNER, Member-at-large

RONALD G. BALLINGER, Member

DENNIS BLEY, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

JOSE MARCH-LEUBA, Member

DAVID A. PETTI, Member

PETER RICCARDELLA, Member

ACRS CONSULTANT:

MICHAEL CORRADINI

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

ZENA ABDULLAHI

CHRISTINA ANTONESCU

CHRISTIANA LUI

QUYNH NGUYEN

MICHAEL SNODDERLY

ALSO PRESENT:

KATI AUSTGEN, NEI

BRUCE BAVOL, NRR

ERIC BENNER, NRR

BEN BRISTOL, NuScale

SARAH BRISTOL, NuScale

ROBERT CALDWELL, NRR

PAUL CLIFFORD, NRR

MICHAEL DUDEK, NRR

SARAH FIELDS, Public Participant

PAUL INFANGER, NuScale

MARVIN LEWIS, Public Participant

PHILIP McKENNA, NRR

MICHAEL MELTON, NuScale

SCOTT MOORE, Executive Director, ACRS
REBECCA PATTON, NRR
ZACK RAD, NuScale
HANNAH ROOKS, NuScale
STEPHEN VAUGHN, NEI
MICHAEL WATERS, NRR

C-O-N-T-E-N-T-S

P R O C E E D I N G S

9:30 a.m.

CHAIR SUNSERI: The meeting will now come to order. This is the first day of the 674th Meeting of the Advisory Committee on Reactor Safeguards. I am Matthew Sunseri, the Chair of the ACRS. I'll call the roll. Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley?

(No audible response.)

CHAIR SUNSERI: Charles Brown?

MEMBER BROWN: Here.

CHAIR SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Present.

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Present.

CHAIR SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Here.

CHAIR SUNSERI: Dave Petti?

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Like the gavel, Matt.

CHAIR SUNSERI: Yeah, thanks. Peter Riccardella?

MEMBER RICCARDELLA: I'm here.

CHAIR SUNSERI: And myself. Okay. We've got Dennis Bley on here. I thought I saw him on the list.

MR. NGUYEN: Dennis, I unmuted you, Dennis.

CHAIR SUNSERI: Dennis, we can't hear you.

MEMBER BLEY: I can. Hi.

CHAIR SUNSERI: Okay, great. All right. We have a quorum, and I would like to also note the presence of Michael Corradini and Stephen Schultz, our consultants on this matter this week. The ACRS was established by Atomic Energy Act and is governed by the Federal Advisory Committee Act. The ACRS section of the U.S. NRC public website provides information about the history of the ACRS and provides documents such as our charter, bylaws, Federal Register notices for meetings, letter reports, and transcripts of all full and subcommittee meetings, including all slides presented at the meetings.

The Committee provides its advice on matters -- on safety matters to the Commission through its publicly available letter reports. The Federal Register notice announcing this meeting was published on May 22nd, 2020 and provided an agenda and instructions for interested parties to provide written documents or request opportunities to address the Committee. The Designated Federal Official for this meeting is Ms. Zena Abdullahi.

During this meeting, the Committee will take up the following: Regulatory Guide 1.236, Pressurized Water Reactor Control Rod Ejection and Boiling Water Reactor Control Rod Drop. We intend to produce a letter on this topic. Second, Reg Guide 1.187, Guidance for Implementation of 10 CFR 50.59, Chances, Tests and Experiments Regarding Digital Instrument and Control Upgrades. We also intend to produce a letter on this topic.

We will continue our review of NuScale area of focus on boron redistribution, and this will take up the bulk of our time during this week's meeting. Time permitting, we will consider the content of our final letter report on NuScale DCA, and we have a planning and procedure session scheduled for Friday morning.

As reflected in the agenda, portions of the NuScale session may be closed in order to discuss and protect information designated as sensitive or proprietary information. A phone bridge line has been opened to allow members of the public to listen in on presentations and committee discussion. We have received no written comments or requests to make oral statements from the members of the public regarding today's or this week's sessions.

There will be an opportunity for public comment, and we have set aside time in the agenda for comments from members of the public attending or listening to our meetings. Written comments may be forwarded to Ms. Zena Abdullahi, the Designated Federal Official. A transcript of the open portions of the meeting is being kept, and it is requested that speakers identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

As this is the continuation of our use of virtual meetings, we are still applying our lessons learned from previous meetings. And so those lessons learned are that the presenters should pause frequently to allow members to interject questions or ask to interject comments or ask questions. We will be taking short breaks approximately every hour for ergonomic considerations.

Additionally, participants should mute themselves when not speaking. It can be very distracting when there's background noise, especially when you have 48 participants right now. So you can imagine. And we do have the capability to mute people from our end if we think that there's a distraction occurring. Are there any questions about the meeting logistics from the members?

(No audible response.)

CHAIR SUNSERI: Okay. I have two items of current interest to bring up. The first, as we contemplate the return to face-to-face meetings, we are following Agency guidance. Right now, there's a graded approach being put in place. There's four phases, zero, one, two, three. We are currently -- I think we're currently in Phase 0, maybe transitioning to Phase 1. But from all our studying of the phases, it looks like we will not continue with face-to-face meetings until we are securely in Phase 2 of that plan. And there'll be more discussion of this during the PMP session later this week.

Second item is because of our extensive workload as we try to complete our NuScale DCA review, we are planning an extra meeting in a week in July. So normally, we only have one meeting per month. We're planning an extra meeting, and that's right now targeted for the week of July 20th. And once again, more information will be provided during the PMP session.

So that's all the opening comments that I have. We will continue with the agenda now on Regulatory Guide 1.236, Pressurized Water Reactor Control Rod Ejection and Boiling Water Reactor Control Rod Drop. And I turn to Walt Kirchner, the Subcommittee Chair, to lead us through this second. Walt?

MEMBER KIRCHNER: Yes, thank you. Good morning. Thank you, Mr. Chairman. Today -- let me back myself up. On May 5th, 2020, the combined ACRS Metallurgy and Reactor Fuels and Thermal-Hydraulic Phenomena Subcommittees held a meeting on Regulatory Guide 1.236, Pressurized Water Reactor Control Rod Ejection and Boiling Water Reactor Control Rod Drop Accidents, Regulatory Guide 1.236.

In today's meeting, we'll hear presentations on the topic. There's a long history related to this Regulatory Guide. The staff briefed the ACRS back in 2007 when this was in its genesis and again in October 2016. In today's meeting, the staff will present the finalized draft of what was Draft Guide 13.27, now Regulatory Guide 1.236. And I note the timeliness of this topic given our agenda later this afternoon. With that, we'll now proceed and call on Paul Clifford of the staff to make his presentation. Paul?

(No audible response.)

MEMBER KIRCHNER: Matt, am I still connected?

CHAIR SUNSERI: Yeah, yeah, you are. I'm looking at Paul. He's muted right now. Paul, if you're talking, unmute your line. There you go. There you go.

MR. CLIFFORD: That's not the first time I've done that.

CHAIR SUNSERI: Go ahead, Paul. Good morning.

MR. CLIFFORD: Good morning. Hello, I am the Senior Level Advisor for Reactor Fuel in the Office of Nuclear Reactor Regulation. I have been in NRR's Division of Safety Systems since 2003. Prior to that, I worked in the commercial nuclear industry for 16 years.

The focus of my 30-plus years of experience has been in fuel design and performance, core reload safety analysis, and plant operations. I will be presenting -- I will be providing a brief presentation, which is kind of an abridged version of what was presented back in early May on Reg Guide 1.236, which provides guidance for evaluating a nuclear reactor's initial response to a postulated control rod ejection or control rod drop accident.

Today, we will start off with an overview of the postulated reactivity insertion accidents and applicable regulatory requirements, then a brief summary of the guidance document, and a timeline of the staff's guidance and how it evolved with the expanding empirical database from in-pile prompt pulse testing programs. I will describe stakeholder comments received by two public comment periods, then we will walk through the guidance with emphasis on what has changed since 2016 which is the last time the full committee was briefed. Then I will describe cladding hydrogen uptake models, which were developed to aid in the implementation of this guidance. And finally, I will describe staff efforts to support a relatively new industry initiative on fuel rod burnup extension. On to Slide 3.

The safety significance of a reactivity insertion accident is evident from the fatal accident which occurred at the U.S. Army's prototype modular reactor SL-1. On January 3rd, 1961, SL-1 experienced a prompt critical power excursion leading to a steam explosion as a result of an improper central control rod withdrawal. All three operators were killed as a result of the physical trauma received in the violent explosion.

Even if the operators had somehow shielded themselves from the explosion, lethal amounts of radiation was released into the building. On the left, you see an old INL safety poster, which shows what remained of the SL-1 reactor. This nuclear accident was likely on the minds of the AEC when they drafted the general design requirements a few years later.

So GDC-28 limits the amount and the rate of reactivity insertion to protect the reactor coolant pressure boundary and ensure a coolable geometry. In addition, Parts 50 and 100 establish limits on radiation exposure for the general public. Reg Guide 1.236 provides an acceptable means to meet these regulations. Moving on to Slide 5.

Reactivity insertion accidents are safety significant because of their potential ability to challenge fuel rod integrity, fuel bundle geometry, and the integrity of the reactor pressure boundary. The uncontrolled movement of a single control rod out of the core results in a positive reactivity insertion that promptly increases local power. This movement of a single control element is considered the limiting reactivity reinsertion accident. Of the various postulated single failures to a control rod drive system which may initiate an uncontrolled movement of a single control rod, the PWR control rod ejection and BWR control rod drop are the considered the most limiting scenarios for the current operating fleet. On to Slide 6.

Building upon the latest research data, Reg Guide 1.236 represents a significant advancement in guidance. It separately captures fabrication, burnup, and corrosion effects on fuel rod performance under RAI conditions. Section C.1 defines limits on the applicability of the guidance. Section C.2 provides acceptable analytical inputs, assumptions, and methods. Section C.3 provides fuel rod cladding failure thresholds based on multiple failure mechanisms. Section C.4 directs the reader to the applicable guidance for regulatory consequences. Section C.5 provides allowable limits on RCS pressure. And Section C.6 provides allowable limits to ensure coolable geometry.

Appendix B and Appendix C were provided to help with the implementation of the guidance. Appendix B provides transient fission gas release correlations, and Appendix C provides acceptable cladding hydrogen uptake models. So that's kind of a very brief outline of the Reg Guide itself. Now on to Slide 7.

This slide shows the evolution of Regulatory Guides beginning in 1974 with the release of Reg Guide 1.77 and ending in today's briefing. Reg Guide 1.77 provided guidance for PWR control rod ejection only. And at the time, it was based on a very limited database, and I'll show that in the next few slides.

1980, there was a publication which reevaluated the data up to that point and made recommendations for changes to the guidance. In 2004, it was RIL-0401 issued by the Office of Regulatory Research which identified new phenomena and ultimately concluded that there was sufficient margin in the existing operating fleet such that immediate action wasn't necessary, but at the same time recommended updates the guidance. In 2007, the staff issued Interim Acceptance Criteria and Guidance and Standard Review Plan which is NUREG 0800, Chapter 4.2, Appendix B.

2017, we went out for public comments in DG-1327. And in 2019, we went out for a second round of public comments, and I'll be talking about those. But first, let's get back to the empirical database which drives this guidance. In-pile prompt critical power excursion type testing is required to understand the phenomena, identify damage mechanisms and failure modes, calibrate analytical models, and establish analytical limits to ensure acceptable fuel performance.

In 1974, the year Reg Guide 1.77 was issued, the empirical database consisted of 10 in-pile prompt reactivity insertion accidents conducted at the Special Power Excursion Research Test Reactor Program, known as SPERT. This figure here presents the data that was available at that time. It shows as a function of peak radial fuel enthalpy versus fuel rod or fuel specimen burnup.

The closed symbols represent the failure where failures were reported, the open symbols where failure was not reported. And as we move forward, you'll see the same type of -- how the data is presented with the failed closed and the open symbols denoting non-failure. And you'll also notice as you see the population grow in the data, there's different symbols for the different test reactor programs.

So moving on to 1980. From 1978 to 1980, a series of in-pile tests were conducted at the Power Burst Facility in Idaho. These additional tests suggested a need for new analytical limits. A threshold for coolable geometry was reduced from 280 calories per gram to 230 calories per gram. And the threshold from cladding failure was reduced from 170 calories per gram to 140 calories per gram for irradiated fuel.

However, based on advanced analytical methods, it was concluded that no imminent safety concern existed in the operating fleet. As such, the guidance was not revised. However, many plants implemented reduced limits. By 2004, the empirical database had expanded significantly with in-pile test programs being conducted in France, Japan, and Russia.

In response to reported PCMI cladding failures at lower than expected deposited energy, the NRC completed a detailed safety assessment which was published in RIL-0401. Once again, based upon the research in advanced analytical methods, the staff concluded that there was no imminent safety concern. However, at that time, it was recognized that the guidance needed to be updated. So in 2007, the staff issued, as I mentioned, SRP 4.2, Appendix B which was interim guidance, which included new cladding failure thresholds, coolability geometry limits, and transient fission gas release correlations.

This graph shows where we are today. Tests conducted since the interim guidance was issued or highlighted here in red. This data, including the latest and greatest, was used to form this final guidance which is in Reg Guide 1.236.

I think it's worth mentioning that the amount of data that has been generated in the last 10 years has slowed down significantly from what we've seen in the past, and that was due to post-Fukushima. I think we saw the information coming out of NSRR in Japan started to diminish. CABRI was shut down as they transitioned from a sodium loop to a water loop. And then they ran into some regulatory issues I believe that had to do with seismic qualification of the reactor building. And that delayed CABRI for 10 years.

But now, we're starting to see an uptick in data, and we expect more and more data in the next few years, driven a lot about by accident tolerant fuels. But CABRI is up and running. NSRR is back up and running. And now we have the TREAT facility in Idaho, which is expected to start producing more data. So we're living exciting times now.

Now we're on to Slide 12. So the next two slides talk about the public comments we received.

Following the ACR briefing in 2016, DG-1327 went out for public comments. Comments were received from 12 stakeholders with a total of 124 comments. Over 100 comments were accepted and prompted changes to the guidance. This pie chart shows the distribution of comments to the various area of the guidance. In addition, public workshops were held during and after the public comment period.

In 2019, DG-1327 went out for a second round of public comments. Comments were received from seven stakeholders with a total of 54 comments. Over 30 comments were accepted and prompted changes to the guidance. And this updated pie chart shows the distribution of comments received in 2019.

Slide 14 summarizes major changes which were prompted by the public comments. First, we expanded the fuel burnup range to 68 gigawatt days for metric ton uranium rod average burnup, and we'll talk about that later in the presentation. That's in Section C.1 of the guidance.

We improved the analytical requirements in Section C.2. There was significant changes to the analytical guidance. For example, we separated the PWR and the BWR guidance to make it more useful and more easily read. We revised the PCMI cladding failure threshold curves in Section C.3. We removed the radiological source term information, which was previously in Section C.4, and that included analytical requirements, fission product gap release fractions, and analytical procedures. And they will be moved to a future revision or Reg Guide 1.183.

We amended the implementation section to reflect the revised permission guidance on backfit which is in Section D of the guidance. And we added cladding hydrogen uptake models in Appendix C. Okay. So before we move on and we start getting into -- hold on a sec. Before we move on and start getting into the major sections of the guidance which are updated, are there any questions?

(No audible response.)

MR. CLIFFORD: Not hearing any, we'll continue. So on to Slide 16. On this slide, I'm going to show you photographs of fuel rod specimens from the SPERT-CDC test program. When we define an analytical limit on damaged core coolability, what we are trying to preserve is the fuel pellet stack within the fuel rod cladding within a fuel assembly bundle array, essentially a known configuration which both shows the geometry which can be modeled and demonstrated to be coolable but also limits fuel-coolant interaction.

And here's the progression which shows increasing energy deposition and the effects on the fuel rod. As you can see as we get up above 300 calories per gram, the rod is no longer within a known configuration and you start to see cladding melting, deformation, fuel melting, and dispersal. So on to Slide 17.

Here is the guidance to ensure you have coolable geometry. It consists of two parts. A loss of fuel rod geometry limit, 230 calories per gram, is based on the earlier test at SPERT, PBF, and NSRR, purely an empirical limit. Note that this has not changed since 2016. And second is a limited centerline melt which avoids fuel-coolant interaction.

It's worth noting of the two criteria which are separately evaluated, fuel melt becomes more limiting at about middle of life, around 30 gigawatt days. Note that the combination of the two preserves coolable geometry and satisfies GDC-28. And there's only been editorial -- slight editorial changes relative to 2016.

Okay. On to Slide 18, we're going to get into radiological consequences. So in order to perform radiological consequence assessment, it requires a conservative estimate of the total number of failed fuel pins from all failure modes. That includes high temperature cladding failure from prompt critical scenarios. DNB and CPR are thermal limit cladding failures for non-prompt scenarios, PCMI cladding failure, and cladding failure as a result of fuel melt. And there's separate guidance for each one of these.

It also requires a conservative estimate of the fission product release fraction from each fuel rode, and that includes what is accumulated in the fuel rod plenum region from steady-state gas release, transient fission gas release which occurs during -- as you would expect, during accidents, and any additional releases as a result of fuel melt. The guidance associated with the fission product inventories has been moved out of this Reg Guide and into a future revision of Reg Guide 1.183. And that was prompted by public comments.

Next we'll get into the cladding failure threshold. The first one is high temperature cladding failure threshold, and on the screen is the guidance itself. It consists of multiple failure thresholds. The first results from a ductile failure mode and the second from a brittle failure mode.

All of these failure modes are associated with boiling prices, and the first one, the brittle failure, has to do with oxygen induced embrittlement of the cladding. The ductile failure has to do with cladding creep, ballooning and bursting. And as I mentioned, they're divided based on the severity of the event for prompt critical event scenarios. There is an empirically-based failure threshold, which is shown here on this figure. And for nonprompt, we fall back to the DNBR thermal design list.

Failure mode is from PCMI. That's pellet cladding mechanical interaction, and here's the guidance --- here's the text, sorry, that's in the guidance. Cladding failure threshold curves are provided as a function of fuel enthalpy rise versus cladding hydrogen content. And the reason we chose this metric is because the data shows that the failure of the cladding is more sensitive to hydrogen content than it is burnup.

And besides the overall concentration of hydrogen in the cladding, PCMI is also sensitive to the zirconium hydride distribution and orientation within the cladding wall itself. So cladding distribution is influenced by thermal and mechanical treatment during manufacturing and also by the stress state prevailing during hydride precipitation. This first micrograph shows a cross section from a hybrid of PWR cladding manufactured in the stress-relieve annealed state.

The OD oxide layer is up here. It's clearly visible at the top of the micrograph. These lines here are zirconium hydrides, which are precipitated along grain boundaries. Hydride precipitants preferentially precipitant along circumferal direction in the stress-relieve annealed state.

In addition, hydrides preferentially reside towards the cooler outside surface. So hydrides will precipitate in a cooler region of the cladding but also in a higher stress state. So here you see very high concentrations of what we call hydride rim. And as you can notice down towards the bottom, there's less. So upon the failure mode here is from the OD in. And so you get an immediate crack in the oxide layer which goes in a brittle fashion through the hydride lines and then it kind of becomes more in a ductile fashion, this classic 45 degree angle here.

The second micrograph shows a cross section from a high burnup BWR cladding manufactured in a fully recrystallized state. And RXA cladding exhibits randomly oriented hydride distributions and orientation as you can see. There's not that clean orientation here where it's more random.

However, the radial hydrides provide a pathway for crack propagation. As a result, RXA cladding is much more sensitive to hydrogen content. As you'll see, crack begins on the outside, and the oxide starts following these radially oriented hydrides. And then you start to see more of a ductile fashion towards the end.

So in summary, PCMI failure is sensitive to both the overall concentration of the hydrogen and to the orientation of the hydrogen. So both have to be accounted for in the failure mechanism. As a result, the staff developed separate failure curves. There's an SRA cladding failure threshold curve for high temperatures. There's also one for low temperatures. There's an RXA cladding failure threshold curve for high temperature and for low temperature.

MEMBER BALLINGER: This is Ron Ballinger. Back on Slide No. 21 for the BWR, is that the liner on the inside?

MR. CLIFFORD: Correct. This is a liner

cladding. As you can see, there's a high concentration of hydrides in the sponge region.

MEMBER BALLINGER: Yeah.

MR. CLIFFORD: And we'll get into -- talk about we developed separate curves to account for that also. We'll get to that. Thanks for bringing that up. So we've developed four different PCMI failure curves, and I'll just kind of walk through them.

They presented as a function of the increase in peak radial average fuel enthalpy versus excess cladding hydrogen. This plot here shows one of the curves that's presented in Reg Guide 1.236, and it also shows the previous version of this curve which was in DG-1327. Here's the SRA hot. Here's the SRA cold. Here's RXA hot and RXA cold.

Okay. That brings me into the next discussion which was just brought up. In response to numerous fuel rod failures during normal operation in the BWR fleet in the 1970s and '80s, the industry developed barrier cladding. The root cause of these fuel failures was PCI stress corrosion cracking. Barrier cladding consists of a natural or low alloy zirconium liner on the ID of standard Zirc-2 cladding and has been shown to be less susceptible to PCI stress corrosion cracking.

One unexpected benefit of the liner was its higher affinity for hydrogen. This micrograph, similar to the micrograph we showed in the RAI failure on the previous slide, shows a cross section of irradiated Zirc-2, the cladding segment. The zirconium hydrides are clearly visible.

Notice a concentration of hydrides within the cladding lining on the ID. Here's the -- some of this at the other one, there's a higher concentration of zirconium hydrides in this barrier liner. Hence, the liner depletes the base metal of the detrimental effects of hydrides. And studies have shown that the liner remains ductile even with the higher concentration of hydrides.

This plot shows the applicable empirical database used to develop the RXA PCMI failure curves. The blue symbols represent test segments consisting of Zirc-2 cladding with barrier lining. Note that these barrier tests are the most important since they define the shape and slope of the curve.

The test results shown in blue were shifted to account for the presence of up to 30 percent of the zirconium hydrides within the barrier liner. Using the scale test results, the staff developed RXA PCMI cladding failure curves for both barrier and nonbarrier fuel types. So we essentially have now six PCMI failure curves, SRA cold, SRA hot, RXA cold, RXA hot, RXA with barrier cold, RXA with barrier hot. So are there any questions on cladding failure thresholds before we move on?

(No audible response.)

MR. CLIFFORD: Okay. Moving on to Slide 28. Okay. As I mentioned earlier, in addition to RIA type guidance, we also provided some guidance which would help with the implementation of the Reg Guide. So in support of the 50.46(c) rulemaking several years ago, the staff developed acceptable conservative cladding hydrogen uptake models.

These models were part of the public comment period for DG-1263 in 2014 and were published in a draft Reg Guide 1.224 in 2015. These models were also presented during ACR briefs on 50.46(c). However, given the status of 50.46(c), the staff decided to include these hydrogen models here in this Reg Guide because they're needed to implement the hydrogen-dependent PCMI failure threshold curves.

This figure shows the BWR hydrogen uptake model along with the supporting database. For PWRs, conservative hydrogen pickup fractions were provided. And this figure here shows the predicted cladding hydrogen content using the conservative 20 percent pickup fraction for Zirc-4 versus the measured cladding hydrogen content. So essentially, we took the available alloy-specific database of cladding hydrogen content measured and we defined a conservative uptake fraction, which would bound the majority of the data. And that's what was provided in Reg Guide 1.224 and is now reflected in this Reg Guide here.

MEMBER BALLINGER: This is Ron Ballinger again. I mentioned this during the subcommittee meeting. But with respect to Slide 28, what's not shown is the difference between M5, optimized Zirlo, and Zircaloy 4. Since Zircaloy 4 is no longer -- effectively no longer in use for fuel cladding, this slide, while correct, is not reflective of the current status of PWR cladding, I don't think.

MR. CLIFFORD: So that is correct. Zirc-4 is no longer loaded as batch fuel in the United States. Zirlo, optimized Zirlo, and M5 are the three that are used today. In addition, so we have two effects of alloy composition which are reflected in the guidance. The first is there is alloy-specific hydrogen pickup fraction which is based on the data, and you can see changes for each of the alloys.

And also, to implement this, you're using a best estimate alloy-specific corrosion model, which each of the vendors have approved. So they would capture the corrosion rates for each of the alloys in their approved models, and then they would apply this conservative alloy-specific hydrogen uptake -- sorry, cladding hydrogen uptake fraction to their models. So they would capture the alloying effects. In other words, the M5 would have a very, very low corrosion rate, and in addition, have a lower pickup fraction rate. So as a result, the hydrogen at the end of life would be much lower than you would see in the Zirc-4, which would have a higher oxidation rate and a higher pickup fraction.

MEMBER BALLINGER: So the slide then, the lower right-hand one for PWR, that predicted versus measured line is for Zircaloy 4, using the Zircaloy 4 model, right?

MR. CLIFFORD: Correct. That's just for Zirc-4 using a Zirc-4 model. And there would be one of those plots for each of the alloys.

MEMBER BALLINGER: Okay.

MR. CLIFFORD: And that's what was used to come up with the pickup fractions. But to implement these, as I mentioned, each of the vendors would use their accrued oxidation models which vary based on alloy.

MEMBER BALLINGER: Yeah, it would be good to have slides which include the predicted versus measured for all of the models and the data on them.

MR. CLIFFORD: Yeah. And the only reason I didn't get into a lot of details is because this isn't something I developed for this application. It was developed back in 2014, and it's been presented in more detail in the past. That's the only reason.

Okay. The next topic, which is Slide 29, is burnup extension. So in support of the near-term licensing actions which we expect, to extend allowable fuel rod average burnup from roughly 62 gigawatt days to 68 gigawatt days, the staff completed a critical assessment of the empirical database supporting Reg Guide 1.236. And that is published there, that ADAMS ML number.

For each portion of the guidance, the staff investigated the sensitivity to burnup and assessed the extent of the empirical database available for each portion of the guidance. That means each section of the guidance, meaning the high temperature failure threshold curves, the PCMI failure threshold curves, the core coolable geometry analytical limits, and the fission gas release correlations. Based upon this work, the staff was able to extend the applicability out to the projected goal for the industry of 68 gigawatt days. And we went into more detail on this four weeks ago.

For the sake of time, we're moving on, the final slide, conclusions. So based upon the latest research data, revised research data, and new analysis and international perspectives, the NRC has developed the guidance that's in Reg Guide 1.236. It represents a significant advancement in guidance.

As I mentioned earlier, it separately captures fabrication, burnup, and corrosion effects on fuel rod performance under RAI conditions. ACRS and stakeholder involvement started prior to 2017. There's been several ACRS briefings beginning with the Interim Guidance. Actually, ACRS briefings began back in 2003, I think, when -- before RIL-0401 was issued. There's been numerous public workshops and three rounds of public comments if you consider the interim guidance, and then here the final guidance.

VICE CHAIR REMPE: So Paul?

MR. CLIFFORD: Yes.

VICE CHAIR REMPE: This is Joy. I have a comment. During the subcommittee meeting, as I recall, I mentioned that perhaps the technical basis document might be useful because there were a lot of changes made, sometimes even in the most recent round of public comments. And I think your response was, yeah, there is basically a patchwork of references, and this would be a good recommendation to come from ACRS. And in your opinion, what's the likelihood of such a knowledge management document being generated at this time with other pressures going on in the Agency? Is it likely that's going to occur without some sort of push perhaps from ACRS?

MR. CLIFFORD: I mean I think we've got a lot of work coming down the pike. If we look at burnup extension, enrichment extension, accident tolerant fuel, certainly, a recommendation from the ACRS would put a lot more pressure on us to get it done. I think it's an excellent idea. And I think if you recommend it, there'd be 100 percent chance it'd get done in a timely fashion. If you don't recommend it, I think it'll be put on a priority list. But I'm not sure where it would lie on that priority list.

VICE CHAIR REMPE: Thank you for your comment.

MEMBER BALLINGER: This is Ron again. The CABRI tests, the original CABRI tests, that was a fast reactor test, right?

MR. CLIFFORD: Correct, in a sodium loop.

MEMBER BALLINGER: In a sodium loop. And so the deposition rates that were achievable with that configuration will likely be quite different than the conversion to the water loop. Am I right? In other words, when they do test using the water loop, are they going to try to duplicate the original test in the sodium loop?

MR. CLIFFORD: Yeah, and that's exactly what they're doing. That was the SIP-Q which was run last year. SIP-Q, Q being qualification, which they tried to duplicate one of the previous tests. So they're trying to benchmark it.

I think the weight of deposition is driven by the helium-3 loop. Basically, they have a coil with helium-3 which absorbs neutrons, and then they quickly evacuate it.

MEMBER BALLINGER: Yeah.

MR. CLIFFORD: And that's what drives the shape or the width of the pulse. I still think -- I think they have the same system.

MEMBER BALLINGER: Okay. Do we have documentation of the comparison so far?

MR. CLIFFORD: Unfortunately, the test was not successful. It turned out that, in the preparation of the specimen, there was some flaws and the rod became waterlogged. So when they tested the rod, instead of -- they expected it to survive up to 140 calories (phonetic) per gram, but it failed at 30.

MEMBER BALLINGER: I think I do remember that. Okay. But they're planning on doing a proper comparison still?

MR. CLIFFORD: Correct. So, there was a test that was originally scheduled for, I think, March or April. But I think it got postponed due to the COVID-19. But they're expecting to run two to three tests a year.

MEMBER BALLINGER: Because when I look at the -- it's a graph on Slide 29. I'm just doing a ballpark number here, but it looks like a very significant number of them were from the original CABRI test.

MR. CLIFFORD: Slide 29?

MEMBER BALLINGER: The squares.

MR. CLIFFORD: Right.

MEMBER BALLINGER: Especially out at high burnup.

MR. CLIFFORD: The squares, right. So the others are kind of, like, a barrel shape. I was kind of running out of symbols. So those little barrel shapes, those are all the NSRR. And I believe there's about 80 of those NSRRs, by far the vast majority of the population we have. But, as I mentioned, we expect more from CABRI and from TREAT (phonetic) now. So, we expect a lot more data, so it's pretty exciting.

MEMBER BALLINGER: Thank you.

MEMBER KIRCHNER: Other members, further questions of Paul?

Hearing none, Mr. Chairman, do we turn now to public comment?

CHAIR SUNSERI: If you are finished with your presentation and material, yes, it would be appropriate.

MEMBER KIRCHNER: I think, Paul, you're finished at this point, aren't you?

MR. CLIFFORD: Correct, yes.

MEMBER KIRCHNER: Thank you for an excellent presentation. I note that this was 30 slides of very detailed information in about 30 minutes. So, well done.

Okay. So, Mr. Chairman, I think we can turn to any public comment.

CHAIR SUNSERI: Okay. So, comments, let's open the public line for comment.

Thomas, can you hear me?

(No response.)

CHAIR SUNSERI: Christiana, do we know if the public line is open?

MS. LUI: I am testing that right now.

CHAIR SUNSERI: Thank you. Any members of the public, if you're on the line and can hear, would you make a -- at least voice your presence so we know the line is open?

(No response.)

CHAIR SUNSERI: Christiana, what'd you find out?

MS. LUI: Probably the lines are muted.

CHAIR SUNSERI: Okay. Is Thomas available? I don't see him on the line. Is there anyone else that can unmute that line besides Thomas?

MR. MOORE: Mr. Chairman, this is Scott. Thomas, I think, has the only link to the public line. So we'll have to come back to that and get Thomas. He's directly patched into the public line.

CHAIR SUNSERI: Okay. All right, then.

MR. MOORE: So we'll work on that.

CHAIR SUNSERI: Okay. So, I guess what we need to do here is put the public comments on hold until we know we can get that line open. We know that we owe them the opportunity.

And let's see. We are at the agenda, here, around 10:20. So, Walt, you have a report drafted for this topic?

MEMBER KIRCHNER: Yes, I have a letter drafted for this topic for this Reg Guide. So, it's a long letter. What is our timeframe, Mr. Chairman?

CHAIR SUNSERI: Maybe you can read that letter in by 11 o'clock.

MEMBER KIRCHNER: Oh, definitely, yes.

CHAIR SUNSERI: If we can get that read by 11 o'clock then we'll take a break at 11:00. And that would put us pretty much on time.

MEMBER KIRCHNER: Yeah. I will need the staff's assistance to put the letter up, because I do not have a hard copy of that letter.

CHAIR SUNSERI: Right. So, Scott or Sandra, are you available, Sandra Walker?

MS. WALKER: Yes.

CHAIR SUNSERI: Can you pull up the Reg Guide 1.236 draft report, draft letter?

MS. WALKER: Okay. Let me look for it now.

CHAIR SUNSERI: And Scott or Larry, will

you report when we have reached Thomas and can get that public line open. We'll just pause where we're at to let them comment.

MR. MOORE: Yes, Chairman. We'll do that. And Larry had to drop off for another meeting.

CHAIR SUNSERI: Okay.

MR. NGUYEN: Sam, you don't need to transcribe the reading of the letter.

CHAIR SUNSERI: But we do need him to hang on for the next part.

MR. NGUYEN: Correct.

CHAIR SUNSERI: So I suppose at this --

VICE CHAIR REMPE: We also have to transcribe the public comments whenever they are available, correct?

CHAIR SUNSERI: That's correct. That's correct. So what we'll do now is I'm going to time mark this. We'll go off the transcript at this point in time so that you don't have to record all this back and forth to getting the phone line set up.

(Whereupon, the above-entitled matter went off the record at 10:23 a.m. and resumed at 10:24 a.m.)

CHAIR SUNSERI: Sam, you with us?

MR. NGUYEN: Yes, he says yes.

CHAIR SUNSERI: Okay. All right. So the public line is open. Do any members of the public have a comment or statement they would like to make in regards to Regulatory Guide 1.236?

(No response.)

CHAIR SUNSERI: Can any members of the public listening in simply acknowledge their presence so that we know that the line is open?

PARTICIPANT: Hello.

CHAIR SUNSERI: Okay. Thank you very much. Any members of the public wishing to make a comment, please do so at this time. State your name and your comment.

(No response.)

CHAIR SUNSERI: All right. There are no public comments. Thomas, we can close the public line. At this point, we will go off the transcript.

(Whereupon, the above-entitled matter went off the record at 10:24 a.m. and resumed at 11:17 a.m.)

CHAIR SUNSERI: Okay. It is 11:17. We are reconvening the session. Do we have our transcriber online?

MR. NGUYEN: The bridge line and transcriber are activated.

CHAIR SUNSERI: Okay. I'm going to do a quick roll call to confirm a quorum. Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley?

MEMBER BLEY: Here.

CHAIR SUNSERI: Charles Brown?

MEMBER BROWN: Here.

CHAIR SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Yes.

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Yes.

CHAIR SUNSERI: Dave Petti?

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: Present.

CHAIR SUNSERI: And myself. All right. So we have a quorum.

As a matter of unfinished business from our last session, there was a member of the public that had wished to make a public comment on the phone line but wasn't able to do that. So he sent it in.

I'm going to read in this comment. And just keep in mind that we don't respond to the comments. But I wanted everybody to hear the comment so that we can consider it in our further deliberations. So let me pull this email up.

All right. Here is the comment. And it is from Matty F. My question is when and whether the RG will be updated as new CABRI and TREAT data comes in with an addendum to use for accident power fuel with coating and non-Zircaloy iron-chromium-aluminum clad?

That's the comment, so it's in the record now. And we'll close that item up. And we are ready to transition now into the next topic, which is Reg Guide 1.187, Guidance for Implementation of 10 CFR 50.59, Changes, tests, and experiments regarding digital instrumentation and control upgrades.

So, Charlie, I'll turn it over to you as Subcommittee Chair for any introductions and to lead the discussion.

MEMBER BROWN: Okay. I'll keep it fairly straightforward. All the members were at the May 20th subcommittee meeting, so the presentation was -- as you most probably remember, there was a discussion at the end between NEI and the staff regarding part of their clarification for 4.3.6 in the Reg Guide.

And so they've had an opportunity over the last two weeks to work that out. We did get a copy of the revised highlighted Reg Guide. I think it was yesterday, which still highlighted where the changes were. And then I guess I will let Eric go ahead and make some opening comments, explain what the issue was, and how they then resolved it. Eric, I'll turn it over to you.

MR. BENNER: Thank you, Member Brown. Yeah, we're just going to go -- we heard some feedback, both from the members and other stakeholders, at the subcommittee meetings. We've made a number of changes that we feel are responsive. We understand that it may not be still as clear as some stakeholders would like where we think we've made a good faith effort in those comments.

We feel pretty comfortable that the document that we presented to you today, or have shared with you and will discuss today, is a solid guidance document. We note that we will perform inspector training. We will have a public meeting close to the issuance of the document, and we would participate in any industry workshops that the industry intends to have. So if there are areas that could benefit from additional discussion, we would intend to use those forums to provide that further clarification.

MEMBER BROWN: Okay. Eric, I didn't want to interrupt you. Go ahead if you've got some.

MR. BENNER: Nope, that was the end of my statement.

MEMBER BROWN: Okay. So I take it from your statement that you and the staff is currently -- you considered the changes you have made to be where you can go relative to the various back and forth?

MR. BENNER: Yes.

MEMBER BROWN: And subsequent to this meeting, your intention is to be able to issue it?

MR. BENNER: Correct.

MEMBER BROWN: Okay. I just want to make that clear to everybody as we go through. And I will let you go ahead and make your presentations.

MR. BENNER: Okay. With that, I will turn it over to Mike and Phil.

MR. McKENNA: Okay. Good morning. This is Phil McKenna. I'm a branch chief in the Division of Reactor Oversight. Next slide, Tekia.

Okay. Again, the purpose of this brief was, again, we received a letter back in 20 June 2019 to come brief the ACRS on our final product of the Reg Guide and to explain how the exception in the draft Reg Guide was resolved. Next slide, please.

And one slide on the timeline. From the last ACRS full committee meeting, we had several public meetings where we discussed examples and proposed language changes to the Reg Guide. With that, we came to a conclusion in the April-May timeframe when NEI submitted their final version of Appendix D on May 13th for endorsement. Next slide, please.

Just a reminder for the exception, we're only talking about one of the criteria in the 50.59 rule, and that was Criterion 6, which is create the possibility for a malfunction of an SSC with a different result than any previously evaluated in the FSAR as updated. Next slide, please.

This was the exception in the Reg Guide. In the draft Reg Guide, this slide is not meant to be readable but just to show you the length of the exception. And, basically, it dealt with Step 5 and Step 6 of Section 4.3.6 in Appendix D, where we took exception to using the term "safety analysis" in lieu of "FSAR as updated" when they were making -- or when a user would go through that six-step process. Next slide, please.

Again, we held a public meeting in June where we went over examples. And in that public meeting, NEI did clarify when they were talking about safety analysis they did not mean accident analysis. They meant anywhere where a safety analysis resides in the FSAR.

And also in that meeting when we presented the examples, we realized in our Reg Guide that the current wording could lead a user, a licensee, to submit a license action request when it wasn't necessary. So we knew the Reg Guide wording needed to be adjusted. Next slide, please.

So, again, this was the major change to Appendix D, the revised wording in blue. And Section 4.3.6 and the six-step process where the wording of safety analysis was removed, and the added words were "malfunctions of an SSC important to safety previously evaluated in the UFSAR," which brought the language in the six-step process closer to the rule language. Next slide, please.

So, now I'm going to go into the clarifications in the Reg Guide itself. There are two new clarifications, which Mike Waters will discuss, and I'll go over the older clarifications that may have been slightly reworded based on public comment period that we held back in 2019.

So, the first clarification is in regard to the relationship of NEI 01-01. That document is still endorsed by the NRC, but we made clear in the clarification that in the endorsement of NEI 96-07, Appendix D, it's only applicable to digital modifications and not generically applicable to the entire 50.59 process. Next slide, please.

On human-system interface, again, this was reworded slightly from the draft Reg Guide. But this clarification highlights that in 96-07, Rev. 1 proper, in that, that human-system interface automatically screened in to a evaluation. In this case, NEI 01-01 changed that guidance and is highlighting in the endorsement of Appendix D that we should use the screening guidance that is in Appendix D even though that differs from NEI 96-01, Rev. 1 proper. Next slide, please.

And, lastly, this, again, was a clarification that was in the old -- or the draft Reg Guide. In resolving the comments, we had removed one of the clarifications and used this clarification to resolve the comment, revise the words slightly. We got feedback from NEI that that revised wording may have been a little misleading. So we changed the wording back to the wording that was used in the draft Reg Guide. So, this is one change from the 5/20 subcommittee meeting. Again, we said we would go ahead and use the wording that was in the draft Reg Guide.

Next slide, please. Okay. Now I'm going to hand it over to Mike Waters, who will talk about the final two clarifications. And, again, these were new clarifications from when we last briefed the ACRS full committee in June of 2019.

MR. WATERS: So, good morning. As Phil previously noted, Section 4.3.6 has a six-step process to help determine whether results are bounded by existing analysis in the FSAR. And, as a reminder, Step 6 of the text in Appendix D provides guidance for verifying that both basic assumptions in the FSAR are still valid and that the new results of the CCF are still bounding in terms of satisfying the FSAR acceptance criteria.

The two phases to highlight are the basic assumptions of acceptance criteria. The Reg Guide provides those two clarifications on understanding and use of these. This is needed because there's not an existing definition or discussion of these concepts in

NEI 96-07. Bottom line, there's a third bullet that the broader clarification on acceptance criteria is NRC has determined for 50.59(c) that licenses may also consider where all applicable acceptance criteria are satisfied to demonstrate that no possibility for a malfunction with a different result has been created.

This clarification is important to make because NRC considers this to be a different approach than the current guidance in 96-07 for addressing different results. And we wanted to make sure that this was clarified for future use when someone has both Appendix D and 96-07 side-by-side for addressing different results. And as far as NEI comments -- and Phil, please correct me -- we just had minor edits here to this clarification as a result of the comments. Next slide, please.

Again, this is actual text from the Reg Guide. And this is what we called a two-prong test looking at basic assumptions and acceptance criteria. The basic concept here, again, with this test is that licensees will need to ensure that the existing analysis results can be correctly compared to the results of the proposed change. In the context, the wording of Section 4.3.6 of Appendix D, basic assumptions relate to concern of the validity of existing evaluations of malfunctions.

So the clarification here was revised based on the comments we heard from NEI at the last subcommittee meeting. The clarification was revised. It does note that the appendix specifies that the single failure criterion in this type of basic assumption. In addition, the clarification revised to clarify that the term basic assumptions includes assumptions such as (telephonic interference) reactor protections systems would be performed and that create engineered safety system functions will be performed. It may also include assumptions regarding the extent to which normally operating systems function, and extent to which normally operating instrumentation and controls are assumed to function.

This revised clarification is based on the construct of accident analysis chapters and the language we use in our SRP for reviewing accident analysis. At the subcommittee meeting, there was a question raised by NEI regarding a clarification on the methods evaluation and the reference to decreases in redundancy and diversity. So we revised the Reg Guide to note that departures from methods evaluation are evaluated under Criterion 8 and the detailed guidance is found in Section 4.3.8 of NEI 96-07.

We also agreed that the detailed guidance for Criterion 2 in NEI 96-07 address the reductions of redundancy from potential CCFs. The NEI guidance for Criterion 2 states that a change that would reduce component redundancy would require NRC approval. We believe that's sufficient. They don't need to have that as a basic assumption.

The second prong, the acceptance criteria we talked about earlier, just to re-highlight, there's multiple clarifications. Primarily, that Reg Guide notes that applicable acceptance criteria must be based on the licensee's FSAR. It does note that licensees may need to refer to supporting documents referenced in the FSAR to determine applicable criteria.

It also clarifies for the purpose of complying with the rule licensees cannot use regulations, the SRP, or any other documents not in FSAR licensing basis as applicable acceptance criteria. This is really important because Criterion 6 requires comparison to results in the existing FSAR. I believe here, too, there were some minor wording, and we added a sentence suggested by NEI.

With that, that's the summary of the clarifications. Just to reiterate, because the use of basic assumption and acceptance criteria is new here, and we wanted to provide clarity to both licensees and NRC inspectors in avoiding uncertainty down the road. I'll turn it back over to you, Phil.

(Pause.)

MR. McKENNA: Sorry. I was on mute. Next slide, please, Tekia. Okay. So, this is the final slide in the presentation, which summarizes the changes we made --

MEMBER BROWN: Phil, can I interrupt you for a second?

MR. McKENNA: Absolutely.

MEMBER BROWN: I went through the highlighted version. Can you go back to the previous slide and make sure Mike is available? This paragraph, what did you say initially about this? These words, are these the ones that are now reflected in the revised version subsequent to the 20 May?

MR. WATERS: This is actually text from Appendix D, Step 6. So this is the text we are clarifying. This is the primary text where it says basic assumptions no longer being valid, e.g., single failure assumption is not maintaining, or if an existing safety analysis is no longer valid. So this is text from actual Appendix D. In the clarification we do quote this text. What I said verbally was our clarification to this guidance right here.

MEMBER BROWN: Okay. Let me backtrack a second here. When I go back to your Section D, which is whatever number this is, 2b, 2d, which is the basic assumptions and acceptance criteria. I'm looking at the 5/20 version. It looks like -- this looks like what I read on the 2020 May version. Is that correct? You all quoted that out of Step 6.

MR. WATERS: Yes.

MEMBER BROWN: Is that correct? Okay. I'm trying to make sure that was in the version we reviewed, this was a pullout that you quoted. And then you provided clarifications.

MR. WATERS: Exactly.

MEMBER BROWN: Okay. And so the clarifications that you're going to talk about are the stuff you highlighted that come after this pullout that you're working on. Is that what you're going to be doing, Phil?

MR. McKENNA: Well, yes, I will summarize it. Mike just went over what the changes were on that clarification from the 5/20 meeting. So, the major change was to the definition of basic assumption where we removed any of the language that mixed in Criterion

8 with method of analysis. And then we added language from the SRP which describes basic assumption. So that was the major change to basic assumption.

MEMBER BROWN: Okay. And that's down in the -- if I look at the paragraph right after this inset paragraph that you all copied, that's the failure of either prong of test results is the paragraph I'm looking at. You made a small change right in the second sentence. The previous version stated, as stated above, this is new guidance not already in 96-07. That was referring to that paragraph. You all revised that to say this guidance is not provided. Is that just wordsmithing, or is there something hidden in that?

MR. McKENNA: No, there's nothing hidden in that. That was just a clarification that made it more clear to the user. And that was based on a recommendation from NEI.

MEMBER BROWN: Okay. And then the remainder part of that, which says, which does not discuss basic assumptions in this context is then repeated. So all right. So it's a little bit of wordsmithing then.

MR. McKENNA: That's correct.

MEMBER BROWN: Okay. So the key elements

come in the following paragraph where you talk about the first prong. And, fundamentally, from what I can see, almost everything is taken -- the first prong, you made some fairly wide-ranging changes.

MR. McKENNA: That's correct.

MEMBER BROWN: If somebody hasn't read the words, you might -- I'm just giving you a heads up. You might need to provide -- don't speed go through this. You better kind of explain the remaining changes in the first prong paragraph and the subsequent paragraph, as well as the one that comes in the second prong paragraph. Okay?

MR. McKENNA: Yes.

MEMBER BROWN: It took me a while last night, walking my way through it, to pick up some of the nuances, which I've now forgotten. Okay. That's all I wanted to make clear where we were in the original reviewed document. You can go on.

MR. McKENNA: Okay. Next slide. So, again, this summarizes the points made in the 5/20 subcommittee meeting and how we drafted those points.

So, the first point was that it appears to unnecessarily insert the purpose of Criterion 8 into consideration of Criterion 6. So, all through that final exception -- or, sorry, final clarification in the Reg Guide, we removed any language that talked about method of evaluation and put one pointer in one paragraph that said method of evaluation is a evaluated under Criterion 8. So we've resolved that comment that way. In several places in that clarification method of evaluation was mixed in to the description.

MEMBER BROWN: Okay. I remember that. And I saw that you did remove those. Okay. Thank you.

MR. McKENNA: The next comment was that it may not fully account for revised Section 4.3.6 guidance. So, again, the major revision we made to the final clarification which we just discussed on basic assumption and acceptance criteria, we revised the definition of basic assumption, removed any discussion there on method of evaluation, and then added text in there which further defined, in our view, what basic assumption is. And that --

MEMBER BROWN: Go ahead. I'm sorry. Go ahead.

MR. McKENNA: Yeah, and that was the five examples we pulled out of the accident and transient analysis section of the SRP.

MR. WATERS: Phil, we also removed the

linkage to reduction in redundancy and diversity, which was a significant comment we heard.

MR. McKENNA: Yes. Thank you, Mike. So, one of the significant comments that we received from NEI was that we shouldn't have brought in the redundancy comment in from Criterion 2. So we removed that also.

MEMBER BROWN: So that's -- the sentence you removed was the one that stated, "further, for purposes of this guidance, basic assumption may include assumptions such as redundancy, diversity, defense-in-depth in addition to the single failure criteria assumption given in 4.3.6."

MR. McKENNA: That's correct. That was removed.

MEMBER BROWN: That sentence has been removed because it's covered in Criteria 2?

MR. McKENNA: That's correct.

MEMBER BROWN: Okay. All right. Got that.

MR. McKENNA: Okay. And then the next one which I had covered in an older clarification --

MEMBER BROWN: Before you go on, could you provide the committee with -- when you say you added or you revised it, the key add here is, with the guidance in 4.3.6, list the single failure criteria as a type of basic assumption. Then you added the words, in addition, the basic assumptions include but is not limited to assumptions that credit plant reactor protection system functions will be performed, credited engineered safety functions will be performed, these are examples, regarding the extent to which normally operating plant systems will function and regarding the extent to which operating plant instrumentation control are assumed and safety-related systems or components continue to meet their requirements. Those are the key examples that you provide?

MR. McKENNA: That's correct, for the definition of a basic assumption.

MEMBER BROWN: Okay. All right. Was that -- did you have any -- I don't want to use the word blowback. Were there any concerns with those examples?

MR. McKENNA: Not on our end. I mean, we had --

MEMBER BROWN: I'm not asking you to tell me what NEI thinks. We'll see what that is. But, from your perspective, this provided some of the clarifications that you wanted to make sure came out?

MR. McKENNA: Absolutely. So, we felt that, in the Reg Guide -- sorry, in the Appendix D, where it talked about basic assumptions, it gave, for example, single failure criteria that we really needed to have a definition for basic assumption for the UFSAR.

MEMBER BROWN: All right. Okay. Go ahead. You're going on to your third bullet, I think, next.

MR. McKENNA: Right.

MEMBER BLEY: This is Dennis Bley. I just want to sneak one minor thing in. I read through this pretty carefully, and I think you guys did a good job. For me, it clarified a lot of things. For other members, if you've been reading through this, the yellow highlight isn't the only thing that changed. Some of the other words changed, like the stuff Charlie was just talking about here. But it works pretty well.

The only minor nit I would ask you about is the first prong of the test paragraph. Now that you've clarified basic assumption, I don't know why you need the last sentence that says you believe that the clarification is warranted. But that's minor.

MR. McKENNA: Okay. We can take that into consideration.

MEMBER BROWN: Do you have a basic -- do you know why or remember why? See, that's not in the previous -- that was in the previous, yes -- is there somebody in the background? Have I lost everybody?

MR. McKENNA: Nope, nope. We're still here.

MEMBER BROWN: Okay. I thought there was a gang fight going on in the background.

I'm back looking at the first prong lead-in paragraph, which you all did make to lead into what you did in the next paragraph. And I just want to make it clear that those words were in the previous version. It doesn't really do anything other than it states your belief that you needed to clarify some stuff. Anyway, so, go ahead with your third bullet, I guess.

MR. McKENNA: Okay. So, for the third bullet on this slide, again, this dealt with one of the clarifications that was in the original draft Reg Guide about the RIS 2002-22, Supplement 1. Again, we revised that wording back to the original wording in the draft Reg Guide. We agreed with NEI's comment on that.

MEMBER BROWN: Okay. The way I read this

one, Phil, is you also made a change to just the title for Item C.

MR. McKENNA: Right. I forgot to point that out. That is correct.

MEMBER BROWN: It was software failure, and now it says sufficiently low likelihood of software common cause failure.

MR. McKENNA: That's correct.

MEMBER BROWN: It's clearly a better example of what you're talking about with the RIS reference. And I didn't remember, when you talk about -- said you went back to the original, is that the one in the November of last year?

MR. McKENNA: Yes.

MEMBER BROWN: 2019?

MR. McKENNA: Well, it was for the Reg Guide that we presented at the June 2019 meeting.

MEMBER BROWN: Oh, the June one. Okay. All right. Of last year?

MR. McKENNA: That's correct.

MEMBER BROWN: Yeah. The public meeting. Is that the public meeting you had after the subcommittee meeting?

MR. McKENNA: That is the document that went out for public comment.

MEMBER BROWN: Okay. All right. Thank you. Is that the only time you've issued this for public comment?

MR. McKENNA: That is correct.

MEMBER BROWN: So that May 30th date still stands?

MR. McKENNA: Yes. Yes. That was the only time we issued the document for public comment with an FRA, right.

MEMBER BROWN: Okay. It's relevant to my letter. That's why. I had a question mark by that in my letter. Thank you.

Okay. Go ahead. The major -- just to make sure the members -- since most of them probably have not read all this. And you correct me if I'm wrong, Phil. It looks like the major change going backwards was after the words -- in the document we reviewed on May 20th, right after the sentence that ended "for the purpose of 10 CFR 50.59 evaluation." You added back in "and may be used in conjunction with Appendix D, Revision 1." That was back in the earlier June version, correct?

MR. McKENNA: Say that one more time, Member Brown.

MEMBER BROWN: Okay. I looked at the

first Item C, 2C. It's worded roughly the same until you get until the end where you added "and may be used in conjunction with NEI 96-07, Appendix D, Revision 1."

MR. McKENNA: That's correct.

MEMBER BROWN: Okay. So, yeah, there was a minor -- I think you changed provide to providing. All right. I just wanted to make sure people understood that there was -- it was really just referencing the Appendix D, Revision 1 that we've been dealing with, relative to the RIS.

Now where are we? Are we on Bullet 4 or Bullet 3? Does anybody else have any comment on anything that I just said? Clarifications?

(No response.)

MEMBER BROWN: Okay. Go ahead, Phil.

MR. McKENNA: So, the final comment we heard from NEI during the presentation on the May 20th meeting was that the two-prong test that we describe in the clarification was not new, that holders or licensees have always used the two-prong test. So we slightly modified that wording in the Reg Guide to say that it's new guidance for the two-prong test, to recognize that users may have to use the two-prong test before.

So, that is the end of --

MEMBER BROWN: Hold it. Hold it. Hold it.

MR. McKENNA: Yeah.

MEMBER BROWN: Don't run away from me here. You actually added a bunch of stuff in addition, you had some what I call purple highlighting change. But then you added this whole sentence to talk about, "nonetheless, some FSARs may not clearly identify or specify acceptance criteria." It seems to me you modified that a bit to be more clear relative to where they get acceptance criteria.

MR. McKENNA: So, that is correct. So, we did, in the final paragraph of the Reg Guide, we made some editorial changes to that to make the identifying acceptance criteria clearer. So, we combined the final two paragraphs of the Reg Guide and reworded that to what we think is a more clearer how to identify acceptance criteria.

MEMBER BROWN: Yeah, okay. I just wanted to make sure that's clear. You didn't add anything, but the way you -- it seemed to read better to me than the old one.

MR. McKENNA: Thank you.

MEMBER BROWN: Dennis, did you have any

problem with that one?

MEMBER BLEY: No, I think the changes they made are all good improvements.

MEMBER BROWN: Yeah, that's what I thought, also, unless -- from the standpoint. I think it was a productive effort, although it's been compressed in terms of trying to get it done. I know it's been difficult.

All right. So, that's the third bullet. If you want to go on to the next slide, you can. I have no idea where we are in slides now.

MR. McKENNA: The next slide? I believe that was the final slide.

MEMBER BROWN: Before we transition, do any of the other members have any other questions?

I will iterate to the other members, I did not presume any of you, since we just got this yesterday, but Dennis and I did walk through this thing, and this seemed to address the stuff and makes some improvements pretty clearly in our estimation.

So, if there's no other questions, why don't we go ahead and switch over to NEI? Matt, do we normally take five minutes here or something like that, ten minutes, to let them switch over or for people to walk around for an ergonomic break?

CHAIR SUNSERI: Yeah, I mean, we can do that, but it's only been 30 minutes since our last break. So, go ahead. Just transition.

MEMBER BROWN: Okay, fine. NEI, you want to go ahead and take the slides?

MR. VAUGHN: Yes, Member Brown. This is Steve Vaughn with NEI. I will bring up our slides right now.

MEMBER BROWN: Okay.

MS. AUSTGEN: And while Steve does that, this is Kati Austgen with NEI. Can you all hear me okay?

CHAIR SUNSERI: Yeah.

MS. AUSTGEN: Okay.

CHAIR SUNSERI: Are you going to be doing the talking, Kati?

MS. AUSTGEN: I will be doing the talking, yes. So, Steve Geier is normally with us. Unfortunately, he's out on a personal matter right now. So I'll convey his regrets that he cannot be with us.

MEMBER BROWN: Matt? Matt? Is Matt still there?

CHAIR SUNSERI: Yes.

MEMBER BROWN: I need about three minutes to go take care of a loose end here. Can we take three minutes for this transition?

CHAIR SUNSERI: Yes, okay. So we'll resume at 12:00 o'clock.

MEMBER BROWN: Okay. Thank you.

CHAIR SUNSERI: So we are in recess until 12 o'clock.

(Whereupon, the above-entitled matter went off the record at 11:54 a.m. and resumed at 12:00 p.m.)

CHAIR SUNSERI: It's 12:00, so we'll reconvene. I'll call the roll. Ron Ballinger? Dennis Bley? Vesna is here, okay. Charles Brown, you're there.

MEMBER BROWN: Yes.

CHAIR SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: I am here.

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba?

MEMBER MARCH-LEUBA: Yes.

CHAIR SUNSERI: Dave Petti?

MEMBER PETTI: Here.

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Yes.

CHAIR SUNSERI: Pete Riccardella?

MEMBER RICCARDELLA: Present.

CHAIR SUNSERI: Okay, and myself. We have a quorum. Ron, I'm sure, will be joining us shortly. All right, so we have the NEI slides up. You may continue, Charlie, and NEI.

MEMBER BROWN: Okay, Steve, do you want to go ahead and proceed with the opening comments on the NEI presentation?

MS. AUSTGEN: Actually, this is Kati. I'll just take it.

MEMBER BROWN: Okay, that's fine. Go ahead.

MS. AUSTGEN: Thank you. So, again, this is Kati Austgen with NEI, and our slides, much like the staff's, are recapping what we shared with the subcommittee on May 20, and then we have looked at the staff's updates to the draft reg guide and we still have one more point to discuss on that, and we'll get to that on slide four.

So, our second slide here again gives the summary of changes since the feedback last year from the ACRS meetings and the NRC staff. As the staff indicated, these changes really happened in Section 4.3.6 of 96-07, Appendix D, and that's the section dealing with Criterion 6.

The changes were to include additional guidance on identification of malfunction results applicable to SSCs solely required to comply with regulations and license conditions, and then we clarified the activities which either invalidate basic assumptions in the safety analyses or that do not meet acceptance criteria create a different malfunction result, and so I think the staff represented the content of Appendix D correctly, so we'll go onto our third slide.

We also updated the examples in Section 4.3.6 once we had alignment with the NRC staff on what the guidance in the section should say. We then improved the example wording so that it would more clearly align with that guidance.

We revised the examples to clearly state the objectives and the application of the guidance, and we tried to clearly explain how to compare the results of malfunctions to the associated safety analysis acceptance criteria where it was something that actually dealt with the safety analysis. As I mentioned, some of our examples talk about regulations themselves.

So, then our fourth slide, as I indicated, many of our comments on the last draft and now the last couple of drafts because the NRC staff did update after the May 20 subcommittee meeting, many of those comments have been addressed.

The clarifications that are still there, for the most part, I'll say are good. Again, the staff did address our concerns on things like how we acknowledge the RIS and removing the appearance of bringing in Criterion 8.

However, we're still a bit concerned that the basic assumption clarification appears to confuse the guidance in NEI 96-07, Appendix D, the six step process in Section 4.3.6, and we're not sure that it's really adding the clarity that the staff intend.

So, we view this clarification as unnecessary because the items that NRC seeks to clarify on basic assumption are adequately addressed in Appendix D in our opinion and/or they are understood by safety analysis subject matter experts using their existing processes that already have controls in place to remain within the confines of a particular safety analysis.

So, specifically, safety analysis professionals will know how to perform their work in the context of the guidance in Appendix D, and the

Section 4.3.6 process structure and examples cover the landscape of digital I&C activities needing guidance.

I did hear during the staff presentation that they were attempting to reflect some information from the standard review plan in the items that they've enumerated, and so if this is truly necessary, then a reference would be helpful to ensure that there is common understanding of the staff's intent and that there is some connection to the standard review plan.

I'll pause there for any questions or discussion.

MEMBER BROWN: I guess I'll ask the question. If I want to contrast your -- if I can bring these up together here and make sure I do it right. Your bullets say the clarifications. That's the entire item B, is that correct?

MS. AUSTGEN: Yes.

MEMBER BROWN: The entire item B, the entire item D, whatever other numbers go along with that, so 2.d in the reg guide under guidance --

MS. AUSTGEN: Yes.

MEMBER BROWN: -- or regulatory guidance. So, your point being is that you think it's confusing, doesn't do anything, and the entire thing, the entire two pages or page-and-a-half are unnecessary and should be deleted. Is that the position you're taking or the --

MS. AUSTGEN: Well, so we can get specific to within this 2.d, so Appendix D, Section 4.3.6, Step 6, basic assumptions and acceptance criteria, we stepped through the different paragraphs as you were discussing with the staff what changes they had made.

So, the most significantly revised paragraph that they have within this clarification is the, "In the context of this test, NRC understands basic assumption to refer," and then they enumerate several items, which if I understand correctly, the staff are saying that those items were informed by the standard review plan.

As we reviewed this in preparation for today's meeting, we think that the topics enumerated or the items enumerated are already covered within the six step process of Criterion 6.

They're illustrated appropriately within the examples in Section 4.3.6, and that, you know, again, when industry comes upon a change where they have a digital activity that must address software common cause failure in Criterion 6 because they were not able to make a finding of sufficiently low likelihood, they will clearly have to engage their safety analysis staff.

And again, this aspect of basic assumption is all within the safety analysis wheelhouse and does not need clarification in Appendix D or in this reg guide endorsing it.

So, we simply think it would be cleaner to let the safety analysis professionals follow their existing guidance and process, and not try to summarize it.

MEMBER BROWN: So, you're talking about only the "in context" paragraph?

MS. AUSTGEN: Yes, I mean, certainly we could live without the rest, but the rest doesn't necessarily give us heartburn or add additional confusion, but when we start trying to summarize things and we start saying, "includes, but is not limited to," that's where folks on the industry side start to say, "Okay, well, where are the boundaries? What am I really looking at?"

MEMBER BROWN: Well, this was the same paragraph where the method of evaluation -- that's where you had your concern relative to Criterion 8 last time also.

MS. AUSTGEN: Yes, and we had suggested that the staff delete that outright.

MEMBER BROWN: Well, they did.

MS. AUSTGEN: Yeah, well, they did, and then they added something in its place, and so, again, if something is necessary there, you know, perhaps this could be addressed with some reference to the standard review plan, some reference to, you know, how the staff came up with these things that are captured under basic assumptions.

MEMBER BROWN: Is the staff listening?

MR. McKENNA: Oh, yeah, we're here. This is Phil.

MEMBER BROWN: Were you aware of this before you saw their slides this time? I mean, the paragraph has kind of been there. It's been revised obviously.

MR. McKENNA: Aware of what, Member Brown?

MEMBER BROWN: Of their issue here, or their additional issue.

MR. McKENNA: Yeah, so we've always said up front that since basic assumption is not defined, it needs to be defined. So, NEI did not define basic assumption, so we needed to define it.

MEMBER BROWN: Okay, so from your standpoint right now, this is the way you would issue your reg guide?

MR. McKENNA: That's correct.

MEMBER BROWN: Okay.

VICE CHAIR REMPE: So, Charlie, I'll step into this. I have a question for NEI.

MEMBER BROWN: Yeah.

VICE CHAIR REMPE: The last time we met, I think Kati said, "Well, we can live with the way it was, but some changes would make it better." Can you live with it the way it is now, Kati?

MS. AUSTGEN: I think we would need a little bit more time to reflect on what this particular paragraph means.

So, you know, we got the updated reg guide language on Monday, and, you know, we've digested it as best we can, but clearly we've not reached out to all of our stakeholders.

As I mentioned, I just learned in the course of this meeting that the staff looked to the standard review plan for this information, so we've not had an opportunity to look at that.

It's possible that we could live with it, but I don't know yet, and as I said, I think, you know, folks, licensees have the tools that they need to be able to implement the guidance.

MEMBER BROWN: Let me interrupt. You

know, this has been a very difficult subject for years, decades, and a lot of times, there's words people would like to be a little bit different, but you take it and then you use it to the best that you can with the way you view it, and then you work out the details when you get to an end product some place along the line.

I mean, you either get this out or you don't get it for a while. I mean, in my life, I've had to live with a lot of different things that I didn't particularly care for, but I learned how to work with them.

And whether, you know, you say they're derived from the SRP or not derived from the SRP, it's nothing particularly new. They just enumerated them a little bit differently, and if it only existed with the SRP, maybe you figure you got a little bit more wiggle room.

I'm not trying to be negative. It's just sooner or later, you'd like to get something out that people can work with that improves the overall situation the way we are now, and I'm not trying to make a judgment one way or the other because I can't.

I haven't worked in that world, but at some point, you need to fish or cut bait, and the staff is trying to accommodate and improve the situation, and at some point, you need to be able to work with that. That's just an observation. I'm not making a judgment.

MEMBER BLEY: Charlie, it's Dennis.

MEMBER BROWN: Yeah, Dennis, go ahead.

MEMBER BLEY: We really don't need to go through the arbiters to get something that everybody is perfectly in agreement on. I think --

MEMBER BROWN: I know that.

MEMBER BLEY: -- we have something we can comment on at this time.

MEMBER BROWN: Yeah, I understand that. I'm just trying to make sure -- to provide a little focus of the points, that's all, for subsequent discussion. Okay, so, NEI, are you all finished?

MS. AUSTGEN: Yes, we've got one last slide which just reemphasizes that we do think there have been improvements in the guidance over the last almost year now. We are seeking a common understanding of the guidance as that will provide much needed confidence.

And once endorsed, we'll move onto industry training and we very much appreciate the NRC's intent to contribute to that industry training so that, again, we'll have the common understanding of how these guidance documents work together. That's all for NEI.

MEMBER BROWN: Hold on.

CHAIR SUNSERI: Charlie?

MEMBER BROWN: Yeah, I had a phone call. I thought it was my facility for my wife, but it wasn't. Okay, all right, then I guess at this point, we'll be ready to solicit some comments. Before I do that, are there any additional comments from members before I go off to the public comments?

Okay, hearing none, is the public line open, Christina?

MS. LUI: Thomas, can you please open the lines?

PARTICIPANT: The public bridge line is open.

MEMBER BROWN: I didn't hear that. What did he say?

MS. LUI: The lines are open.

MEMBER BROWN: The line's open, okay, thank you. Is there anybody on the public line that would like to make a comment relative to this meeting? Is there anybody out there that could just say something to let us know that it is open?

PARTICIPANT: It's open.

MEMBER BROWN: Thank you very much. Hearing no one stepping forward, I will go ahead and close the bridge line, Christina. And Matt, I guess that's it. I'll turn it back over to you.

CHAIR SUNSERI: Okay, Charlie, thank you. We've got about 30, 25, a little over 25 minutes left for this session. Do you feel that's sufficient time to read in your letter?

MEMBER BROWN: Yes.

CHAIR SUNSERI: Okay.

MEMBER BROWN: It's not that long. It's only about a couple hundred lines long or so. It's not like Walt's tome.

CHAIR SUNSERI: Yeah, yeah, so let's just proceed smartly through it. Keep focused on that. Let's see if we can get the letter up, and the idea would be to read through and get high level comments if we have sufficient time.

MEMBER BROWN: Okay.

CHAIR SUNSERI: So, Sandra, can we get the Reg Guide 1.187 letter up?

(Whereupon, the above-entitled matter went off the record at 12:18 p.m. and resumed at 1:46 p.m.)

VICE CHAIR REMPE: Okay, so this meeting

will now reconvene. I will start off on behalf of Matt Sunseri to go through the roll call, and if I forget a member out of order, holler at me, okay? Ron Ballinger, are you present?

MEMBER BALLINGER: Yes, here.

VICE CHAIR REMPE: Dennis Bley? Dennis, are you there? It looks like he's not yet on, so we'll skip that. Charlie, are you there?

MEMBER BROWN: Yes, I am.

VICE CHAIR REMPE: Vesna, are you here?

MEMBER DIMITRIJEVIC: I am.

VICE CHAIR REMPE: Walt Kirchner, are you here?

MEMBER KIRCHNER: Here.

VICE CHAIR REMPE: Jose, are you here?

MEMBER MARCH-LEUBA: Yes.

VICE CHAIR REMPE: Dave, are you on?

MEMBER PETTI: Here.

VICE CHAIR REMPE: I think I -- oh, Pete Riccardella, are you on?

MEMBER RICCARDELLA: I'm here.

VICE CHAIR REMPE: Okay, and I'm going to skip myself, and Matt, are you back on yet? So, then right now, we're missing Matt and Dennis, but we still have a quorum. And Walt, I believe you're in charge of this next session, so I'm going to turn it over to you and let you start.

MEMBER KIRCHNER: Thank you, Madam Chairman. Yes, we're at an important juncture in our review of the NuScale design certification application. We have a major amendment to address. The issues identified related to boron redistribution.

So, we will hear from both the applicant on design changes that were made, as well as from the staff on their plans to complete their review of this amendment.

Again, I just want to underscore I think our expectations, that is the members of the committee, is that from the applicant, we get a thorough description of the design changes that were made and why, and the supporting analysis to demonstrate that these changes mitigate the concerns with the potential of reactivity insertion accidents as a result of boron dilution or redistribution in a number of scenarios.

So, with that, I think we're at a point where we'll turn it over to NuScale, and I believe Matthew Presson is going to make some opening comments and then lead us through this presentation. Go ahead, Matt.

CHAIR SUNSERI: Which Matt are you talking to? This is Matt.

MEMBER KIRCHNER: Welcome back, Matt. No, I'm addressing Matthew Presson from NuScale. I believe he is going to speak first.

CHAIR SUNSERI: Yeah, okay, I am back on. This is Matt Sunseri. I am back online now. I don't know what happened. My Skype froze, but it's all cleared up now.

MEMBER KIRCHNER: Just --

VICE CHAIR REMPE: While we have a quick interruption, can we confirm that Dennis is on too because he did not respond earlier?

MEMBER KIRCHNER: Dennis, are you there?

MEMBER BLEY: Yeah, can you hear me now? I've been yelling.

MEMBER KIRCHNER: Yes, yes, thank you, Dennis, okay.

VICE CHAIR REMPE: Thank you.

MEMBER KIRCHNER: Okay.

MR. PRESSON: All right, well, perfect. Apologies, my mic was on mute, but it seems like that worked out.

MEMBER KIRCHNER: Go ahead, Matthew.

MR. PRESSON: Thank you, Walt, and good

afternoon, everyone on the call. This is Matthew Presson with NuScale, and I'd like to thank you all for your time during this presentation.

The purpose of this presentation is, as you said, to provide information on the design and DCA changes related to this boron distribution topic. So, we presented some preliminary information on the topic in the April ACRS session, and this follow-up looks to provide some of the final changes that were made following that.

So, moving to slide two, the presenters for today will include myself, Matthew Presson, licensing project manager. We also have Paul Infanger, our licensing specialist in Chapter 15.

We'll have Ben Bristol, supervisor of system thermal hydraulics, Hannah Rooks, supervisor of NSSS systems and analysis, and Sarah Bristol, supervisor of probabilistic risk assessment.

Slide three provides our agenda, and slide four will provide a little more background on the topic, but I wanted to provide at a high level here kind of some of that information.

So, following a review of questions that were posed to us in February, NuScale identified that in some specific postulated Chapter 15 events, we did not have the approved analytical tools available to really answer those questions on boron redistribution.

So, in light of our commitment to safety and instead of looking to redevelop those tools, NuScale chose to implement a few targeted design changes to preclude those postulated boron dilution events.

So, during today, as shown on the agenda, we'll be presenting information on the background of these postulated events, the design changes that we incorporated to preclude them, and the analytical results following our review of those changes.

And moving onto slide four, I will pass this off to Ben Bristol and he'll cover a little bit of the background.

MEMBER KIRCHNER: Since you used the word a couple of times, preclude these events, does that include mitigate? And I'm making the distinction because are you saying you're just going to be -- the approaches and the design changes is to preclude the event and mitigate the consequences or just preclude the event?

MR. PRESSON: Got you, yeah, so I think the answer to that would be both. We're primarily focused on precluding those events which kind of fell outside of our analytical basis, but some of the design changes that were implemented do assist in mitigating the event as it progresses, those boron redistribution events.

MEMBER KIRCHNER: Yes, so I don't want to get ahead of you and your colleagues, but, you know, for example, you've added these holes in the riser, and we would be much interested to know how you analyzed their performance and how they were effective in either precluding or mitigating the boron dilution kind of events that are of concern.

MEMBER BALLINGER: Yeah, this is Ron. I'm echoing Walt, but also adding the why. Why were they needed?

MR. PRESSON: Understood, and I believe we should have slides covering that in the open presentation, the why, as well as a little bit of information on their mitigating ability.

We definitely have a lot more design-specific prop information to provide in closed session, but we should be able to provide information on that here in the open discussion.

MEMBER MARCH-LEUBA: Hi, Matt, this is Jose. Let's go into detail on the why a little bit more. Did you do a risk-informed evaluation of -- I'm going to call it Revision 4 of the FSAR, which is the January configuration. When I say Rev. 4, I mean the January configuration, okay?

So, did you make a risk-informed evaluation of the situation? Because you mentioned that your concern is that you didn't have the tools to analyze it, yet you apparently have the tools now to analyze the fix.

MR. PRESSON: Yeah, and the analysis being specifically mixing of boron, so to what degree boron would mix within the RCS.

MEMBER MARCH-LEUBA: Right, and if you use the method that you're going to show us in the closed session, I have lots of problems with those, and we'll go into detail once we close the session because almost everything there is proprietary, but if you use that method and you close the holes, you dilute the downcomer. I mean, there is no question whatsoever that you do.

So, my question is did you evaluate what was the risk of the plant under Revision 4 configuration? That's what a risk-informed evaluation would have done.

MR. PRESSON: Yeah, let me take a second and check with our PRA folks on that. I can say that we can definitely cover the riser holes discussion probably to some extent in open, but definitely in the closed discussions.

MEMBER MARCH-LEUBA: Okay, it's okay. Let me leave that question.

(Simultaneous speaking.)

MEMBER KIRCHNER: Let's leave that question on the table and go ahead. Go on, Matthew, with your presentation at this point because --

MR. PRESSON: Yeah.

MEMBER KIRCHNER: -- we can come back to that.

MR. PRESSON: Yeah.

MR. BRISTOL: This is Ben Bristol. Can you hear me?

MEMBER KIRCHNER: Yes, Ben, we can hear you.

MR. BRISTOL: Okay, Jose, I think we'll get into a little bit of that. I may touch on it somewhat through the next few slides I have, and then we have some PRA-specific insights.

I would say that as we identified the different conditions, most of the analysis of the identification of the condition was performed deterministically, and that led us to the decision to make the design change which we believe was a conservative decision making process with the idea of safety in mind. A detailed analysis of what could have happened under the Revision 4 design configuration, we had looked at that somewhat.

Generally, in terms of the risk insights, what we had seen is that the redistribution phenomena results in boron accumulating in the core region which is helpful for metrics and safety.

There were certain conditions that we could postulate deterministically which that boron, the accumulated boron could potentially be displaced through ECCS actuation, and that was the area that we really focused on the design to ensure that preclusion of the redistribution of the phenomena would allow us to characteristically transition to ECCS cooling without the need for the consideration of shutdown or potential boron core dilution events.

So, that was really kind of the focus of this analysis, and the design changes were carefully made to ensure that they limited the impact in other areas of the design, particularly with the consideration of risk insights.

MEMBER MARCH-LEUBA: And by now, you guys know me and know that I don't like this risk thing, so

I'm really applauding and encouraging what you've done.

Instead of trying to do a more detailed analysis to show that we really don't want to raise SAFDLs or try to figure out whether the frequency is too low or too high and make an argument, you went in there and fixed it.

MR. BRISTOL: Right.

MEMBER MARCH-LEUBA: Great, I mean, that's great. Now, don't get too cocky because when we go into closed session, I'm going to beat you on the model that you used to demonstrate it, but this will work.

We'll have to -- when we finish, when the staff finishes the review, we'll have to figure out if the size, which I don't know if it's proprietary, the diameter of the holes is sufficient, or it's too much, or it's too little, but putting a hole in there will eliminate many, many of these problems, not all of them. We'll come back later.

MR. BRISTOL: Okay, so and I think in the April presentation, much of the information was closed, so I don't have quite as much detail here, but I will be speaking to some of the things we were seeing and then the design changes we were making for the purposes of this public session.

Just in terms of the background, the issue was raised during the February Chapter 15, and actually I think it was the topical report ACRS discussions about particularly the identification of the progression of slower LOCA type scenarios and the potential impact of DHR cooling under those scenarios. We went back and starting looking at those.

MEMBER KIRCHNER: I think we have someone who needs to mute their phone or their computer. Go ahead, Ben.

MR. BRISTOL: Okay, I'll keep moving through slide four here. So, under certain conditions, I think there were two things that we saw that could occur during ECCS actuation that we discussed previously.

One is the condensate that accumulates in containment is generally expected to be of lower concentration than that in the RCS, and should ECCS actuation occur sufficiently late, then the condensate accumulation in containment could push, could have sufficient level to drive a fair amount of the reduced borated liquid from containment back to the RCS and potentially into the core.

The other phenomena that we noticed was a level swell type phenomena where if the riser head uncovered and was cooling on DHR prior to ECCS actuation, the depressurization transient could actually restore the loop to some degree that could drive the RCS coolant back into the core or the downcomer coolant back into the core.

Of those scenarios, we identified that small changes in boron concentration can have a relatively significant impact on reactivity, and so we were motivated to preclude any significant redistribution-related phenomena to ensure that the downcomer concentration or containment concentration couldn't actually work its way back into the core at any significant rate.

So, as we have discussed previously, NuScale entered this into the corrective action program and we started our evaluation of the potential consequences, and we're looking for the design changes necessary to preclude the behavior of deborated fluid entering the reactor core. Next slide, Matthew.

MEMBER KIRCHNER: Ben, this is Walt Kirchner.

MR. BRISTOL: Yeah.

MEMBER KIRCHNER: I think your colleague, Mike Melton, would like to make a comment. Mike, are you there? He may not -- he may be muted. We'll come --

MR. MELTON: Thank you. I'm not muted.

MEMBER KIRCHNER: Okay, go ahead, Mike. Yes, you're on.

MR. MELTON: I can unmute myself. I was going to add a little bit a few slides ago, but I think we got through it, and so I'm going to let Ben continue and then I can interject when I need to.

MEMBER KIRCHNER: Okay.

MR. MELTON: So, thanks for bringing me up and I'll go back on mute. Back to Ben. Thank you.

MEMBER KIRCHNER: All right, Ben, continue, please.

MR. BRISTOL: Okay, next slide. So, this was already touched on a little bit, but just to reset, the boron dilution analysis and distribution analysis that NuScale had done and was reviewed by the NRC was largely centered around the transport mechanisms after ECCS actuation.

So, characteristically, the boil off rate in the core and the condensation in containment and recirculation causes a redistribution effect, and we had spent a fair amount of time evaluating that and confirming that under all conditions where we were in

ECCS cooling mode, that boron was preferentially accumulating in the core, which is provided that it doesn't over accumulate and create boron precipitation-related concerns, then that's helpful for the characterization of shutdown and shutdown margin.

So, as we were looking through that, and Matthew kind of alluded to this earlier, the effects of potentially lower boron concentration entering the core during an ECCS type transience, we had not, you know, developed the methods and models necessary to ensure that the three-dimensional effects of boron distribution in the core wouldn't result in a core safety concern.

Generally, we didn't see significant enough dilution scenarios that would cause a catastrophic core reactivity event. However, with deterministic analysis where we're assuming a rod is stuck out of the core and we're applying calculational uncertainty, it becomes a very difficult problem to prove necessarily that under all conditions we would meet, you know, SAFDLs and acceptance criteria.

In addition, as we were looking through the analysis, we had identified that there were a couple of minor design changes that we could implement relatively straightforward and demonstrate that we could preclude the phenomena from occurring, and therefore making the analysis unnecessary of those conditions.

MEMBER BALLINGER: This is Ron. So, what you're saying is that the holes are basically there for a Chapter 15 problem?

MR. BRISTOL: So, I'll get into that. Ron, I'll get into that in a little bit once we start talking about that, but I would say that the characterization of the potential phenomena is certainly deterministically postulated, but I think as we were looking through it, there was a lot --

There's obviously a lot of benefit in terms of operational simplicity and things that would need to be considered, you know, during event recovery actions, that generally having design features that preclude significant boron redistribution would make the overall design safer and simpler.

MEMBER BALLINGER: Thank you.

MR. BRISTOL: Sure. So, where we are currently in the process, the NRC has initiated an audit reviewing the design changes and the analysis of those design changes, and we're still working through that. Next slide? Thank you.

So, of the events, I'll speak to this for a little bit here. As I mentioned a couple of slides ago, where this all started was the consideration of slower LOCA events that actuated ECCS on high containment level with the consideration that some of those events could take several hours until ECCS actuation would occur.

And because of the figures of merit within generally the LOCA analysis where we're looking to demonstrate core coolability, the additional consideration of boron distribution had not previously been looked at in as much detail.

And our general understanding of the phenomena related to that was as ECCS is actuated, generally we see core transient behavior and fluid is displaced from the RCS into containment until the levels equalize and the pressures equalize, and then slow recirculation of the condensate from containment is established, and we established the stable cooling under that configuration.

As I had mentioned, when we started looking further into it, there was very specific and unique cases where if the ECCS was actuated while the riser level was still relatively high, then there was this swell behavior that we saw that could cause a core in surge type transient phenomena.

Under those conditions, the time frame was still sufficiently short that the overall dilution, while challenging in deterministic analysis space with uncertainties applied, normally probably wouldn't generate a significant reactivity event.

And as we were looking at those cases, it became apparent that if we had events that were eventually going to lead to an ECCS actuation, then we would simply actuate them sooner, and we ended up developing a new ECCS actuation signal which I'll speak to a little bit later. The other phenomena --

MEMBER MARCH-LEUBA: What type of event -- because the one we were most worried about is the various load developing LOCA, I mean a one gallon per minute type of LOCA, the smallest of the small breaks which will take an hour or two before the level in the containment trips the ECCS, and DHRS would have been working and condensing steam on top of the downcomer for hours. But you're talking about a different one now, one that is fast and it can produce flow distribution into the core. Can you explain that one?

MR. BRISTOL: No, I think we're speaking of the same event, right? The larger breaks, and particularly, you know, just for example's sake, if we were to postulate a full break of the discharge line of CVCS, we see the transient progress relatively quickly and there is not enough time for a boron redistribution and DHR-driven condensate effect to cause any significant boron redistribution, and we get to ECCS cooling, you know, well within the first hour of the event transient.

MEMBER MARCH-LEUBA: I agree. It has to be an hours type of event, not minutes.

MR. BRISTOL: That's right. The condensation accumulation rate relative to the volume that we have in the RCS is pretty small. However, events that do spend several hours getting to ECCS actuation, those were the events that we identified the concern with.

MEMBER MARCH-LEUBA: Yeah, unfortunately, the smallest of the small break LOCAs are the ones that have the highest frequency, but keep going.

MR. BRISTOL: Sure. So, that's kind of a high level description of the LOCA scenarios. The other phenomena that we have in the system is under conditions, non-LOCA conditions, we can end up in DHR cooling scenarios.

And the DHR is an efficient enough heat removal system that the RCS temperature will drop and continue dropping, and what happens is the level in the RPV drops or shrinks along with the temperature decreasing.

And the system is designed such that under certain conditions, if inventory hasn't been added, then we would get the RCS level to drop down to the top of the riser, and once that occurs, then there's a potential for continued shrinkage to the point where we could get some steaming and condensing between the riser and downcomer side.

Generally, you would expect an internal circulate convective circulation pattern to be established where boron would continue to be reasonably well mixed.

However, because of the time frames we're considering there and in our Chapter 15 analysis space, clear out to 72 hours, we're observing while the phenomena was very slow in developing, you could potentially start generating a gradient that was beyond the, you know, critical boron concentration in the downcomer.

And the margins that we ended up calculating under those conditions were sufficiently small that we were motivated to provide the flow path, and this is where the riser holes came in, to ensure that the very slow condensation accumulation would be prevented from a boron redistribution standpoint and we would keep where we would limit the amount of gradient that could be developed between the riser and the downcomer to a very small fraction.

MEMBER BALLINGER: This is Ron Ballinger again. I don't remember the number, but what is the tech spec limit on unidentified leakage?

MEMBER KIRCHNER: .5 GPM.

MEMBER BALLINGER: .5 GPM, so a 1 GPM LOCA, if you want to call it that, would be above the tech spec limit and would be noticed right away, am I right?

MR. BRISTOL: Correct.

MEMBER MARCH-LEUBA: Yes, that would be correct, but then you get a scram (audio interference) start.

MEMBER BALLINGER: Okay, so all I'm saying is for something like that to go on for a long period of time is almost problematic because of the tech spec limit.

MEMBER MARCH-LEUBA: No, they don't have any safety grade makeup. They don't have any power to make it up.

MEMBER BALLINGER: Okay, we're getting

conflated with the Chapter 15 with the natural operation now.

MEMBER MARCH-LEUBA: I know, but the claim is that this is a possible plan that can handle anything, and in particular, one gallon per minute, it can handle it, and it will scram.

It will close the containment and the level will start rising, and the downcomer will start operating and you eventually are going to open. So, okay.

MEMBER BALLINGER: Okay, all right, well, we'll keep going.

MEMBER KIRCHNER: So, Ben, this is Walt Kirchner.

MR. BRISTOL: Yeah.

MEMBER KIRCHNER: Another interruption. You've given us some time frames, which is useful. So, have you done kind of like bounding analyses? When do you start accumulating? How long does it take you? Is it more than 24 hours to accumulate a significant amount of diluted water in the downcomer under DHRS operation?

MEMBER MARCH-LEUBA: I believe, Walt, that that's in the proprietary presentation. Maybe we can postpone it until later on.

MEMBER KIRCHNER: Yeah, well, just take that maybe under advisement as a question because I think time, you know, time is a big, another factor for consideration in the review of these analyses. Go ahead, Ben.

MR. BRISTOL: Yes, certainly it's on the, you know, on the order of several hours. What we were noticing under the, you know, the LOCA conditions or the slower leak conditions is that the steam generator would continue to uncover, and as the tubes start to uncover, then it becomes a much more effective condenser, and so that would increase the rate. Those were cases though that we had identified early actuation of ECCS could preclude that event progression quite reliably, and we spent --

MEMBER KIRCHNER: Right, right.

MR. BRISTOL: -- a fair amount of time analyzing that.

MEMBER KIRCHNER: All right.

MR. BRISTOL: The conditions where we're more of a shrinkage-driven problem, those are much, much slower in progressing, and we had, you know, we had identified the time frame of concern being beyond the 24-hour time frame.

MEMBER MARCH-LEUBA: One example I put in one of the papers I wrote was a hurricane is going to hit your plant and you are asked by the NRC to go shutdown and go into a safe shutdown while the hurricane is going through to DHRS operation, and you might stay there for three or four days. And I know it's not the typical Chapter 15 analysis, but it is quite expected anticipated occurrence.

MR. BRISTOL: Sure, and I think under those conditions and normal shutdown, or even rapid shutdown, one of the more important things to do is add inventory in order to, you know, maintain the operability of the module. If the inventory starts shrinking too much, then we'll get an automatic containment isolation.

So, it's one of the key considerations in operability, not necessarily from a core coolability standpoint, but just from an operability standpoint as inventory addition.

So, the other thing we had analyzed is the, you know, anticipated transients without scram, and we had looked a little bit.

Generally, what we see there is that the boron accumulation effects are helpful making those analyses more limiting at the end of cycle condition when there's lower boron concentrations in the system.

Okay, next slide, Matthew?

MEMBER MARCH-LEUBA: No, no, don't go there, not yet. I was --

MR. BRISTOL: Okay.

MEMBER MARCH-LEUBA: All right, I wanted to first say that let me -- I'm not nice to you very often, so in the route of the bypass orifices, the holes, it's a good thing. That was the right answer.

And now we need to argue about the diameter of the holes for you, and we'll argue for a month on that, but it is the right thing to do and it is good that you guys did LOCA and DHRS in hours, but there is a situation that I don't see in FSAR or in any of your slides, and it is the following.

After you have an ECCS actuation, there are a million scenarios that get you there. Okay, I don't care how you got there. You opened your RRVs. Your three levels, the riser, the downcomer, and containment are at about the same elevation.

Now your steam generator is completely uncovered and whatever heat is coming out of the core, which if it's a few minutes after shutdown, will be three to five megawatts.

In an hour, it could be a megawatt, goes into condensing on the simulator, and then when you're in this DCCS mode, you are going to be raining water into the downcomer.

At what rate? I don't know, but the fact that you will deborate when you're in ECCS mode is, I mean, it's almost impossible not to fail to operate. The question is how long it will take.

The problem, and I know you realize this, but I'm not sure that you realize that if now the operator, because he has a rupture on the CVCS line or he doesn't have the proper procedures, he starts CFDS containment flooding and you start raising the level the containment, and that RRV starts flooding water into the top of the downcomer and pushing that deborated downcomer into the core.

So, my claim is that any moment, any time you go into ECCS mode, you start deborating the downcomer. If one hour, 10 hours, 100 hours after this happens, you start containment flooding, you have the same problem that we had before with ECCS actuation.

And Chapter 19 has -- I mean, even your slides here have a line that says, "And we can recover by starting CVCS." It gave me the impression that you just haven't thought this through.

So, don't do it now. Save it for the

closed session or save it for tomorrow, but I'm going to postulate -- I mean, I'm going to tell you that everything you did was good except maybe the model, but my concern right now is ECCS mode, deboration, following by CVCS actuation.

And even if a COL applicant later on decides that that is a bad thing and we're going to have procedures not to actuate containment flooding, they will have to take an exception against your FSAR because your FSAR tells them to use CFDS.

This slide, I don't know what number it is, this slide right here, three or four for now, will tell us to use CFDS to recover from that condition. We got a problem.

MR. BRISTOL: So, I'll start addressing that with the -- I think we agree, and we've actually added a statement in Chapter 15 in the FSAR acknowledging that under ECCS, extended ECCS cooling conditions, that redistribution is expected, and have actually made the statement that any recovery actions will need to consider this with respect to the shutdown margin as part of the recovery actions.

As, you know, as we've talked in previous meetings, those actions cannot be specified, you know, at the design certification stage, but I think I understand your concern and I believe that we have addressed it fairly explicitly now within our FSAR.

MEMBER MARCH-LEUBA: Yeah, but my concern is when somebody takes time to think about this, they'll have to take an exception on your approved design because your approved design says to use CFDS, the containment, yeah, CFDS.

MEMBER KIRCHNER: Now, I just note, Jose, that Ben used a word, extended ECCS operation, so that begs the question. You've probably done some bounding analyses on what amount of dilution would take place in the downcomer. It seems to me that one can then infer a tech spec, that you have to essentially intervene to mitigate the situation in X hours.

MEMBER MARCH-LEUBA: Let me run you by what a LOCA would look like in the plant. A LOCA happens. The scram is automatic. Containment actuation is automatic. Within a few minutes, everything gets -- the ECCS actuates and everything gets --

MEMBER KIRCHNER: Right.

MEMBER MARCH-LEUBA: -- stable and nice. The operators breathe a sigh of relief and call the engineering staff. The engineering staff now starts thinking what happened? Why did it happen? Can we fix it?

In the meantime, part of the engineering staff is also making calculations to figure out what happened to the core, to the fuel with the actual transient, and this takes time.

This is time for the resident inspector, the NRC resident inspector to go into the control room and look over the shoulder, get their cell phone and call headquarters who is going to send out an inspection team that's not going to let you touch the reactor until --

MEMBER KIRCHNER: No.

MEMBER MARCH-LEUBA: -- they show up there and they find out --

MEMBER KIRCHNER: This is not how you operate, Jose. They can do a calculation that shows --

MEMBER MARCH-LEUBA: You have a LOCA.

MEMBER KIRCHNER: You're helping them solve the problem rather than listening to how they've solved the problem, but I would just submit that one can do a bounding analysis on extended ECCS operation and make an estimate of where you get to a point, based on where you are in the life cycle, the beginning of cycle and end of cycle, where you get to a point where you have to be concerned about boron dilution, and that suggests that there's a time limit where you intervene with the containment flood and drain system before you cross that juncture.

But anyway, we're trying to solve their problem. Let's hear from Ben and NuScale what they are doing.

MEMBER MARCH-LEUBA: Yeah, I just wanted to posit the concern I have. Everything else is essentially solved. We need to cross the Ts and dot the Is and review all of their math, but it's solved. I'm still concerned with the ECCS, long term ECCS actuation following by CFDS operation, so, yeah, you can go on.

MR. BRISTOL: Okay, and I think I would add the CVCS has the capability of injecting into the riser, which would be obviously the first choice, and even if that somehow was failed, injection can be applied through the pressurizer spray line, and that dumps -- that would inject boron directly on top of the downcomer, and the injection rates are sufficiently slow that there's a variety of mechanisms where safe recovery can occur.

However, as we've spent some time talking about this, you know, the specifics of those procedures are, you know, not available and not worked out at this stage, but the system has the capability of recovery from a variety of different conditions that could be postulated.

MEMBER KIRCHNER: Ben, would you make a note for the closed session? When one looks at your line diagrams in the FSAR for CVCS, that distinction isn't apparent that when you turn on CVCS that you can control whether it goes into the spray.

I note that somewhere in the FSAR, it indicated that you are continually spraying when the CVCS system is working. So, you've made a distinction that I don't think is apparent in reading the FSAR, nor looking at the line diagrams in Chapter 9.

So, could you take a note of that? Because one of our concerns is that you start spraying, you then quickly drop the pressure, and you can -- you know, the core conditions are saturated as a result.

You get a quick expanse of the inventory that's in the core and the riser, and that will then bring in, you know, the cold, diluted content of the downcomer. Do you see what I'm saying? The depressurization -

MR. BRISTOL: Well --

MEMBER KIRCHNER: -- could induce a downcomer flow in. So, you don't have to answer in real time, but could you explain that perhaps in the closed session?

MR. BRISTOL: Sure, and just to kind of characterize, the conditions under ECCS cooling are already quite depressurized. Once ECCS is actuated, we quickly depressurize the system such that the inventory addition for, you know, proposed event recovery type scenarios would simply just be filling the pressurizer through the spray line.

And I think the only reason we would be thinking of doing that is if we had an indication that the break occurred on the injection line or we had some reason why the injection line, you know, wasn't functional.

Then the spray could be added through the pressurizer, and the pressurizer holes are located over the downcomer, and so it would fall into the downcomer, reborating the downcomer prior to the establishment of long-term passive cooling with the containment flood and drain system.

MEMBER MARCH-LEUBA: My complaint is not that it cannot be done. It is just that we use risk-informed objectives for everything we want to do, but then we introduce on this type of scenarios.

And in my mind, the consequences of putting all that water into the core is terrifying. That this is not something that should be related to the COL, hoping that a COL will do it.

And taking credit for reactions that are complex and require a diagnosis and understanding, I mean I've been to control rooms many times and they do a great job, but they make mistakes too. And I don't see how come that is not part of the PIA.

All the sequences, how come they're not in the risk? Because we're claiming a tremendously low frequency, when we have a really full scenario that depends on the operator identifying it and doing the right thing without safety power.

Anyway, I said it. It's on the record. Go ahead.

MR. BRISTOL: Okay. So I think we're -- are we in slide 7?

VICE CHAIR REMPE: Just so you know, Ben, I think we lost Matt Presson, and we don't have the screen, although we -- the members have copies of your slides and just keep us posted on what slide you're on.

MR. BRISTOL: Okay.

MR. NGUYEN: So Matt just responded in the IM chat, so he's here still.

MR. PRESSON: I can see the screen.

MR. NGUYEN: For the presenter, I recommend stop sharing the screen and try to load it again to refresh for everyone.

MR. PRESSON: All right, will do if I can.

MEMBER MARCH-LEUBA: If everything else fails, get off of Skype and come back in.

MR. PRESSON: Yeah. It's currently not letting me hit the stop presenting button, so jump off and jump back on.

MEMBER KIRCHNER: So this question is for Mike Snodderly. Mike, do you have the ability and authority to put up the slide?

MR. SNODDERLY: I was thinking the same thing. So yeah, I'm going to request the screen control.

MEMBER KIRCHNER: Yeah. And then it seems like we had Matt on audio, so you can just have Ben indicate when he wants to change the slides if you can load it.

MR. SNODDERLY: Can everyone see my slides?

MEMBER KIRCHNER: Yes. We see them, Mike.

So go ahead and --

MR. SNODDERLY: Ben, what slide do you want me on? Ben, first --

MR. BRISTOL: Slide 7.

MR. SNODDERLY: Everyone should be able to see slide 7.

MEMBER KIRCHNER: There it is. Yeah, that's it, Mike. Thank you very much. Go ahead, Ben. And just indicate to Mike when you want to go on to the next slide.

MR. BRISTOL: Sure. So as we've kind of been discussing along the previous slides, the design considerations, primarily two, for the events that we know were going to end up in ECCS actuation, we identified that actuating ECCS sooner would preclude the boiling distribution because of the timeframe required for the boiling and condensing effect that actually caused the redistribution phenomenas to occur, and provided that ECCS was actuated prior to any redistribution phenomena, then we could preclude the phenomena of a large influx of unborated water to the core for the smaller and slower progressing LOCA type scenarios.

The other sort of newer edition at least to the ACS's consideration is the inclusion of the riser holes as a design feature. We have identified that as really being a robust design feature that we could make sufficient to preclude the redistribution phenomena of concern, while not actually impacting the normal operation of the RCS and normal operation of the module itself. So okay, slide 8.

Specifically as related to the ECCS actuation, what we saw characteristically was a depressurization and a pressure in temperature type phenomenon that we could use to identify if we were in an event, you know, with the MPX sensors that already existed in the design, we could target the events where we were losing inventory because of the way that the temperature and pressure observed or measured in the T-hot location that's located at the top of the riser. And specifically if the pressure were to drop while the temperature remained high, then we knew we were in a loss of inventory type scenario as opposed to just a normal DHR cooldown.

And in terms of risk insights, I think I would say this is one of the areas that we've spent some time with the PRA and the events that they analyze, and as the ACRS is aware there's very few causes of core damage -- maybe back up one slide there, Mike.

One of the contributors is events that require an ECCS demand where the valves or a combination of the valves don't reposition as intended. So it was important to us to ensure that we weren't sending events that otherwise were safe and stable on DHR cooling and not sending those events to ECCS just to solve the problem that we were, you know, kind of postulating deterministically.

So there was design consideration that went into what events we were sending to ECCS and attempting to ensure that they were only events that would otherwise have ultimately ended up in ECCS or needed to go to ECCS for extended core cooling.

MEMBER MARCH-LEUBA: And I support everything you said. I mean we don't need to talk to anyone we don't need to. Can you explain to me, do we need this 800 psi? What is it protecting against?

MR. BRISTOL: So 800 psi is we looked at a spectrum of different LOCA events and LOCA progressions with a variety of different, you know, DHR considerations considered, and what we typically observed that 800 psi was about the time at which the riser was starting to uncover.

So that's where the 800 psi kind of came from, from the perspective of the smaller LOCA events, 800 psi was about the time at which the riser would start to uncover. And obviously it's the loop and circulating back that's the first initiator of the onset of more of a boiling and condensing type phenomena where the redistribution phenomena starts to come into play.

MEMBER MARCH-LEUBA: And your core level sensor is non-safety grade, even though it is safety grade because of the standards in the riser, but it's considered not to be safety grade. It would have been to have a scan at another level.

MR. BRISTOL: So we certainly considered the low RCS level, but again as I was just kind of talking about, low RCS level itself doesn't determine if an event is a shrinkage related DHR cooldown event versus a loss of inventory event.

MEMBER MARCH-LEUBA: But you have the same interlocks. But anyway, that's what I have done.

(Telephonic interference.)

MEMBER BLEY: Excuse me, this is Dennis. Jose, when you're talking, could you talk a little more slowly? It gets garbled a bit over this connection.

MEMBER MARCH-LEUBA: Am I getting a bad connection today?

MEMBER BLEY: Well it's not a bad connection, but when you talk real quickly it's hard to follow over the microphones and things we're using.

MEMBER MARCH-LEUBA: So I -- let me repeat. I offer that if I was designing the plan, which I'm not, I would -- I was asked by a member why do we have the 800 psi scam, and I told the member, I don't know. And it turns out now we know the 800 psi is a substitute for the level --

MEMBER BLEY: For level, mm-hmm.

MEMBER MARCH-LEUBA: Yeah. So it's good. Okay. It does occur.

MR. PRESSON: And this is Matthew Presson for a quick correction for the record. On slide 8, that less than 800 psi line should be less than 800 psi, 900 plus or minus 100.

MEMBER MARCH-LEUBA: Okay, perfect.

MR. BRISTOL: Okay, slide 9. So yeah, just to summarize on that slide, the 800 psi with the temperature interlock allows us to identify the loss of inventory conditions while not actuating ECCS for events that otherwise did require ECCS actuation previously.

Another one of the design changes or issues that we had identified, again as I mentioned at the top of the presentation, the level accumulation in containment, if it's above the equilibrium level after ECCS has depressurized the RCS and the RPV, and the pressures between containment in the RPV equalize, then there's a manometer head that can force fair amounts of the containment coolant back into the RCS.

That was quite simple to preclude by simply dropping the containment level actuation point down into the range where nominal containment level is established. So --

MEMBER MARCH-LEUBA: If I remember correctly, on the limiting LOCA you were not dripping on level. I mean the level was providing the initial signal, but you have to wait for the IAV to open. So if you provide a set point up to 52, will the IAV allow you to open then?

MR. BRISTOL: Yeah, and so ---

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: -- record, the level drops two feet above the core inside the vessel because of the IAV. Isn't that --

MR. BRISTOL: Yeah, and that's what I would characterize as -- for the purposes of providing a conservative LOCA analysis, that analysis technique assumes that DHR doesn't function.

Under those conditions, obviously if that were considered, then the condensate accumulation in, you know, in the RPV is characteristically different. The boron transport analysis did not use that analytical technique and instead analyzed something a little bit more realistic to the design, in which case the DHR has the capability of depressurizing the system well below the IAV block range, well prior to the ECCS actuation signal.

MEMBER MARCH-LEUBA: I may have missed it. Was Chapter 15 updated with this new calculation, or at least a mention to it? Because I missed it. So your Chapter 15 has been LOCA, the reference has been LOCA, it still assumes the SRS not working?

MR. BRISTOL: That's correct.

MEMBER MARCH-LEUBA: But for to demonstrate your new 252H level, you have to form a new calculation?

MR. BRISTOL: Yes, that's right.

MEMBER MARCH-LEUBA: And that -- at least on one line, according to the fact that this is the case, because if I look at Chapter 15 SVA, I see that I don't really open the valve or something until the pressure drops below IAV.

MR. BRISTOL: Mm-hmm.

MEMBER MARCH-LEUBA: Obviously, that's not the case. I guess it merits some explanation, a one liner. I don't want to see the plots, understand what you're saying.

MR. BRISTOL: Okay.

MEMBER MARCH-LEUBA: I didn't miss it.

MR. BRISTOL: So slide 10, Mike? Okay, so the riser holds. As we discussed previously, under DHR cooling shrinkage conditions the top of the riser there, the inventory can shrink to the point where that uncovers.

And what we see under those conditions is that the temperature gradient between the riser and downcomer starts to increase with the downcomer becoming cooler and continuing to shrink while the riser remains hot until the point at which the heat removal for the delta T is sufficient to push the decay through the riser wall itself. When we were evaluating that phenomena, it was identified that that's actually a good driving force for fluid from the riser to the downcomer if there was a flow path.

And because of the very small margin or with the very low allowable boron gradient between the downcomer and riser under cold conditions, where, you know, xenon has burned out and DHR, if we're postulating DHR cooling for a great deal of time beyond the 24-hour timeframe, the amount of condensate while very slow in accumulating and developing, it still could become somewhat challenging from the allowable critical boron concentration with analysis uncertainties and, you know, the worst, rod stuck out of the core.

So with that in consideration, rather than maintaining analysis basis that was fairly tight from margin perspective, we went ahead and decided to add the riser holes. And we also recognized that this provided a much more robust design solution and simplified potential event recovery considerations for the more probable events where DHR, extended DHR cooling had occurred and that the potential complexities were around ensuring that the downcomer concentration hadn't dropped to a point that was challenging.

With riser holes we've sized them such that again they had a very small impact on the normal circulating loop, a very small impact on any of the analyses supporting the original SR, and yet providing upflow to ensure that the concentration that develops between the gradient between the downcomer and riser remains quite small.

(Telephonic interference.)

MEMBER MARCH-LEUBA: --- and fixing the problem is always the best thing to do. Keep going.

MR. BRISTOL: So I think that's the end of my presentation. I'm going to pass it over to Paul who's going to talk a little bit about much of the rest of this presentation's focus is on the impacts of these design changes. So if there's no more questions, I'll turn it over to Paul.

MEMBER KIRCHNER: Ben, just that when we get to the closed session -- this is Walt Kirchner.

MR. BRISTOL: Yeah.

MEMBER KIRCHNER: Will you just go over how you chose the level for the location of the holes? Could you talk a little bit about that? I don't want to postulate what I would have done, but I'd just like to hear more detail, i.e., the scenarios that you used to decide where to make the actual penetration, so to speak. The elevation is of interest. Thank you.

MR. BRISTOL: Sure. And I can actually cover some of that in the open session here. What we were looking at was as I mentioned the extended DHR cooling scenarios. One of the things we observe about the normal circulation of the loop is that a good portion of the heat transfer occurs in the bottom half of the steam generator, so any of the bypass flow that occurred from the midpoints and above doesn't actually present a net thermal efficiency loss.

So that was one of the reasons for putting the riser holes at that low elevation was the normal operating consideration, in fact. In addition, they're low enough that even the most severe non-LOCA events where, you know, potentially we have a loss of inventory to initiate the events and then shrink from there, the holes will never uncover during normal DHR cooling scenarios. So those were kind of the two primary considerations that went into that location.

MEMBER KIRCHNER: Okay. Thank you.

MR. BRISTOL: Sure. Go ahead, Paul.

MR. INFANGER: Okay. Can you hear me? Is my mic --

MEMBER KIRCHNER: Yes, Paul. Go ahead.

MR. INFANGER: Okay.

(Telephonic interference.)

MEMBER KIRCHNER: Paul, you're garbled somewhat. Can you speak more directly to your microphone?

MR. INFANGER: Yeah, let me see if I can get closer here. Better. Is that better?

MEMBER KIRCHNER: That's much better.

MR. INFANGER: Okay. So the next section of the presentation is to talk about the FSAR and analysis changes. Okay. So -- and for Chapter 15, we've looked at all of the analyses and looked at what needed to change based on the design changes.

So we looked at the return to power calculation that's in FSAR 15.0.6 and the end of cycle conditions are still limiting for the return to power event. So there's no change to the limiting event.

So the flows through the riser hole will maintain the downcomer greater than the critical boron concentration for events that occur earlier in the cycle, so those became even a less of a concern because all of the events with the DHS and potential return to power, all of those now have the mixing from the circulation flow that goes through the holes and back through to the core.

So the 15.0.6 there was no impact with the results in the FSAR.

MEMBER MARCH-LEUBA: So I'm going to summarize. The boron will return to power is very high sequence activity, which happens at the end of power where you don't have boron in the vessel. So boron solution when you have no boron to start with is not an issue. So absolutely, I second your opinion.

MR. INFANGER: Okay. So -- and also we presented our boron redistribution methodology in response to a request for additional information in RAI 8930. And in that we had done like simple grouping of boron concentration levels in the -- like for three simple groups.

And what the modifications do is they with the ECCS modifications they assure that early actuation of ECCS has flow out of the reactor vessel and into containment, and therefore we get a mixing in containment.

And then when you do have return flow it's very slow flow because the pressure equalizes, and then as level builds in containment you get a slow flow back into the core, into the reactor vessel from the containment, and then you don't run into the same boron mixing concerns you have with getting a large slug from the downcomer or the containment.

So the modifications that we made, the combination of the holes and the revised ECCS actuation set point maintained all of the assumptions that we had in our boron redistribution analysis. We submitted an update to that RAI response documenting the changes and that the -- so what the results are.

I'm moving the screen here. I don't know if we're -- the -- let's go off of another slide on the computer because the -- my WebEx, mine has -- it's disappeared.

The LOCA analysis was redone, and there were some postulated events that actuate on low RCS posture. Most of the steam space LOCAs will now go on low RCS pressure actuation and from the liquid space LOCA.

So there was no change to the limiting end state to power request liquid level events, because the MCHFR events are inadvertent opening of an ECCS valve, either the RVV or the RRV. And in those events the MCHFR occurs in like the first half a second.

So those events are very, very quick so the progression to -- was not significant. And the actuation on the low RCS pressure occurs in the events that still have power available.

For the limiting events, we go on the IAVs or loss of AC power and loss of DC power and the ECCS valves actuate on the inadvertent actuation block release point. So the -- and plus liquid level is mostly the limit is the very small liquid space breaks. So the limiting events I did not change so that the minimum class liquid level didn't change or either did the lowest MCHFR.

Some of the non-limiting events did change in that a handful of tables in 15.6.5 were revised and some because a number of the -- particularly the steam space breaks now go on low RCS pressure, and the sequence of events changes, they go ECCS earlier than previous. So we do update the FSAR, but no limiting results changed in any part of the FSAR. You can go to the next --

MEMBER KIRCHNER: Paul?

MR. INFANGER: Yeah.

MEMBER KIRCHNER: Did you see any significant change in your containment analysis?

MR. INFANGER: No. The limiting case for containment pressure is the inadvertent reactor circulation valve opening, and that entire scenario was not affected by this event. So both on containment level, ECCS on -- well, first, you get the -- you go on AIV. With loss of DC power you go on a loss of on the AIV set point. And --

MEMBER KIRCHNER: Thank you.

MR. INFANGER: And we also -- we looked at the inadvertent opening of the ECCS valves. These had no impact on the limiting event, the RVV opening with power available. The remaining valves will open on low RCS pressure, or in a couple of cases there is a non-safety opening of the valves on low delta P.

As the very fast depressurization, sometimes that can come in before we hit the low RCS pressure set points if they occur around the same pressure range. The RRV was not affected, so the remaining valves open on containment level, and the reactor safety valve of opening events are still bounded by the ECCS valve opening event.

So overall the Chapter 15 changes were relatively minor. We did put in some discussion about how the -- there's with the new signal that the steam space breaks and the larger liquid space breaks open on the new RCS low pressure set point.

That does affect a large number of events, but mostly in the accident progression and as they transition to ECCS earlier than they did before on containment level. So that's the primary changes to Chapter 15. In fact, the mechanical analysis, I'll turn it over to --

MR. PRESSON: And we'll pass that off to Hannah Rooks.

MR. INFANGER: Is Hannah available? Okay, thanks.

MS. ROOKS: Yes, this is Hannah. Can you hear me?

MEMBER KIRCHNER: Hannah, just a little bit louder and closer to your microphone?

MS. ROOKS: Yes.

MEMBER KIRCHNER: And somebody else probably has -- needs to mute their phone. We're getting feedback.

MS. ROOKS: Okay. That there?

MEMBER KIRCHNER: A little more please.

MS. ROOKS: Okay. All right, so this is Hannah Rooks. I'm the supervisor of the NSSS System Analysis group, so I'm going to talk about the evaluations that we performed for mechanical design and analysis impact of the riser hole design addition.

So as Ben touched on already, the holes are located at about the mid-height of the steam generator, and since the majority of the heat transfer occurs in that bottom half of the steam generator, the flow through the riser holes still get most of the cooling across the tubes and therefore it has negligible impact on the normal RCS flow rate.

The holes also do not introduce any structural integrity concerns due to swelling due to vibration, and there's no need to update the comprehensive vibration assessment program technical report. And I have more detail on the SIV evaluations that we performed on the next slide.

And also the holes don't have any impact on the normal DHRS cooldown, and the cooldown curves and the conclusions about DHRS performance that we have presented in section 5.4 of the FSAR do not need to be updated.

MEMBER MARCH-LEUBA: I wanted to ask about that one because we used to have, for a few years, 5.4.11, I believe, and then it was where you can see that they had a separating after two or three hours.

But this is a number, it's two kilos per second flowing through the DHRS, it doesn't cool well. I mean DHRS has improved, which is pretty good, but does it have any like on the final temperature, does that being colder, anything that shouldn't do? Did you look at that?

My point is two kilos per second doesn't sound like much, but a lot greater than zero. And I can tell you DHRS works better with the holes than without the holes. I don't know if it's one degree or 10 or 100, but it's better.

And the question is, with the final temperature and does that affect something else like in terms of practicality, which it won't, and forget about -- so -- but over to you.

MEMBER KIRCHNER: Jose, this is Walt. What you're saying is, it supplements the DHRS. It doesn't actually change the DHRS performance.

MEMBER MARCH-LEUBA: No, it's increasing the heat transfer coefficient outside the tubes of the steam generator, which therefore makes DHRS move more heat.

MEMBER KIRCHNER: But if the flow is from the riser to the down-comer, it's hotter fluid than in ---

MR. BRISTOL: Walt, this is Ben Bristol. So I'll maybe add something here to help a little bit. The normal cooldown curve, the RCS flow rate is around 200 kilograms per second. And that's when the delta T is fairly low. As the riser starts to uncover, obviously then the resistance becomes higher and the flow rate starts to drop.

MEMBER KIRCHNER: Right.

MR. BRISTOL: The two KG per second doesn't characteristically change that temperature gradient increase. Because even though, yes, there is some additional flow circulating, it's too small to really characteristically change that DHR cooldown curve as a function of time.

MEMBER KIRCHNER: Okay.

MEMBER MARCH-LEUBA: My real question is have you calculated it, or I mean it's okay. It's not going to affect anything, because if you cooldown, cooling the temperature like 10 degrees, because mostly we do 10 degrees, I don't see the impact of that.

MR. BRISTOL: Right.

MEMBER MARCH-LEUBA: Okay, continue.

(Pause.)

CHAIR SUNSERI: Please unmute.

MEMBER KIRCHNER: Yes, Ben are you, or did we lose Hannah, or has she turned it over to you, Ben?

MS. ROOKS: No, somehow I got muted. Can you hear me now?

MEMBER KIRCHNER: Yes. Go ahead, Hannah.

MS. ROOKS: Okay. So I was just saying that we did run, with our RELAP analysis, the comparison of the DHR cooldown with and without the holes. And we basically kind of plotted the cooldown curve and compared them. And there's a pretty indistinguishable difference between the two cooldown progressions.

MEMBER MARCH-LEUBA: See, that's the perfect answer.

MS. ROOKS: Okay. So moving on to the

next slide, I guess, 14, so this is some detail, a little more detail about the evaluations that we did for the riser holes. So we looked at particularly turbine buffeting and vortex shedding.

So the holes are, they're part of the upper riser which feeds turbine flow. And therefore, we've already evaluated the riser assemblies for turbine buffeting. And the holes are just a very small volume reduction to the upper riser. So they have really no impact on the structural properties of the riser, and there's no impact to the turbine buffeting evaluations that have already been performed.

And then because there's continuous flow through the holes, any generation of vortices at the leading edge of the holes would be suppressed by that flow. But if vortices were to form, their frequency would not be coincident with any relevant modes of the riser.

And lastly, we reviewed the operating experience, some valid -- there was some vibration damage that occurred with fuel pins due to some cross flow through gaps that developed between baffle plates.

So the riser holes, they would induce a

cross-flow path from the riser to the downcomer region. However, we evaluated the force due to normal flow through the holes, and it's very minimal. And the frequency of that flow would not result in any resonance with nearby components.

So if there are no questions on that, I think I will turn it over to Sarah to talk about PRA.

MS. BRISTOL: This is Sarah Bristol. Can you hear me?

MEMBER KIRCHNER: Yes, Sarah.

MS. BRISTOL: All right. The PRA was part of the team to develop the design solution. It was a collaborative effort with safety analysis, design engineering, I&C, ops. And once finalized, we evaluated the design changes in the PRA. We looked at our thermal-hydraulic models as well as our logic models.

Next slide please. We incorporated the design changes with the riser holes and the ECCS actuation logic into the best estimate NRELAP5 PRA thermal hydraulics model.

The changes to the ECCS actuation logic had the potential to affect the accident sequence prevention as well as the end states. So we have re-evaluated the PRA from a hydraulic calculation to confirm the impact of the change on the Level 1 PRA criteria and accident progression.

The results of the evaluations concluded that cycling reactor safety valve sequences, which are typically modeled following failure of flow trains of the safety related decay heat removal system would now reach this new low RCS pressure ECCS actuation set point.

So in different instances, reactor safety valves cycled through early pressure or stuck open. Also those accident scenarios would now result in this new ECCS actuation.

The additional impact we saw was that, in the low likelihood scenario of an un-isolated chemical and volume controlled system, injection running pipe breaks often continued.

The earlier actuation of ECCS has the potential of increasing the amount of coolant lost from that break from the reactor pressure vessel prior to isolation. So we are now crediting that safety related decay heat removal system to delay the potential event progression, which at times has provided to the operators to provide coolant injections. So we updated the event tree to reflect those two new insights from the design changes.

MEMBER MARCH-LEUBA: Let me interrupt here and go back to my new favorite topic which you'll hear as long as I have a microphone that works, yes. The sequence I'm concerned about is any LOCA that returns the salts in ECCS actuation.

You see a week or two before the NRC inspection team to make up their minds and let you do something, and then operate CFDS. The way I'm reading this, they approve the design, the certified design, it's still on the operator, valves shall use CFDS in those conditions?

If the POL responsible civil engineer says that's crazy, if I turn CFDS, I'm going to push all that operator outcome, and it's the core. So the only recourse would be to take an exception from the approved design.

And you can go to this particular sequence on Chapter 19 and say this is a success sequence because we put water in the core. Yes, you pull up water to get water in the core.

So I still have a hangup here. We have to do something about this. I don't know what to do, but I think this is a hole in the system. I think it's a serious hole in the system actually. Just putting it out there. It'll probably be on here later.

Certainly I know the staff is listening. The staff will do the math and see what all the differences of the program. But it can be a 50/50 chance if you operate ECCS a week or two for the teams to go away and let you do your job, and then you turn CFDS, that is a bad scenario. I put it on the record, and I will repeat it again over, and over, and over.

MEMBER BLEY: Excuse me, this is Dennis. I got knocked off the line just as soon as Jose started speaking. And I don't know if there was an answer in between, or you're on your second round. It's really hard to hear what happened during that time, if somebody could summarize it.

MEMBER MARCH-LEUBA: This is Jose. I did not hear an answer. I placed on the record the scenario, they at NuScale, the Applicant, has fixed the high frequency events by putting those two holes. I applaud them for that. They have done the right thing.

In my opinion, they left a hole on this system. ECCS actuates because of all the inspections, and analysis, and everything that needs to be done. You stay there for a week or two. I mean I don't guarantee. And then when you're ready to transfer that module to the refueling station to work on it and fix the break, you flood it with CFDS ---

(Simultaneous speaking.)

MEMBER KIRCHNER: Jose, I would submit that that's a long time span. And that's not how you operate a power plant. There are ways for them to address this in tech specs phase and operating procedures so that they do not allow the system to sit there for weeks as you're postulating before this core flood and drain system is actuated.

MEMBER MARCH-LEUBA: Can you point me to the tech spec section that says that?

MEMBER KIRCHNER: I'm just proposing to you that there is a fix for that.

MEMBER MARCH-LEUBA: I know there is a fix for that. But what I'm saying is the fix is not in the current FSAR or certified as an application.

MEMBER KIRCHNER: Yes, so we should take that up.

MEMBER MARCH-LEUBA: Yes. It should be. I think the consequences are piling up. And if you look through, I mean even on this slide, we instruct the operator to recover the CFDS.

MEMBER BLEY: Yes. Thanks for giving the reprieves. I figured that's where you were going. I'm very interested in your answer, but I really agree with Jose on this, that if it fits without an answer at this point in time, just putting it in the tech specs will require an exception next time around. And this is all part of one piece and ought to be addressed at this time.

MEMBER MARCH-LEUBA: Yes.

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: The Applicant will ---

MEMBER KIRCHNER: Yes.

MEMBER MARCH-LEUBA: -- will need an answer tomorrow. We have the whole morning tomorrow to think about it. I know this comes cold, the concept, so I don't want you to think on your feet and make commitments in five minutes. Think about it, and leave it for tomorrow.

MR. PREESON: Yes, we'll certainly think about that and come back with any more details tomorrow, Jose. But I think for the NuScale position on that more extreme scenario is that we did provide those updates to the language in Chapter 4 and Chapter 15 to identify those extended ECCS operating conditions so that operators would have the information they need to know that that is something to consider.

MEMBER MARCH-LEUBA: And you won't be surprised that we write a letter, maybe something, some recipes, that the design is incomplete. So that's the way I see it. It can be fixed if you put your heads to it. The same way you fixed the holes, you can fix this too.

But at the moment, the consequences are so bad. And this is not such an incredibly low frequency event. It's any LOCA of any type, that's the same, one gallon per minute leak from an SRV. We get you there. We bring you an inspection team that won't let you fix it for two weeks.

You will completely liberate the downcomer. And as Walt says, what you have to do is the moment you have uneasy situation, flood, we can help, don't wait for whatever you want to do.

But in my opinion, the design is incomplete. This is a sequence, which if you put it on your PRA, this will be a dominant sequence for core average. It won't be 10 to the minus 11.

MEMBER PETTI: Jose, can you help me here? I seem to have lost the sequence of events. You have some sort of a LOCA that actuates ECCS. You somehow assume that the level is below the holes, so they don't work?

MEMBER MARCH-LEUBA: It's got to be below the holes, yes. It's designed to be below the holes.

MEMBER KIRCHNER: It would shrink it, Dave, down, below that --

(Simultaneous speaking.)

MEMBER KIRCHNER: But that's a question we can take up in the closed session meeting.

MEMBER PETTI: Sure, yes.

MEMBER KIRCHNER: That's where I was going --

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: -- containment.

MR. CORRADINI: I think I'd like to take it up in the closed session. Because I'm confused also, just as Dave is.

MEMBER KIRCHNER: Yes.

VICE CHAIR REMPE: So I have a question about the process. We're kind of at a process. The staff is still reviewing this, but if the staff decides, I mean we've heard NuScale say, well we think we've done enough, but we're reviewing what the staff gives us.

The staff may say, hey, what they provided is incomplete. And so I'm not sure, I mean it's good for us to learn what NuScale's proposing and to make comments. But I don't know, I think we're at a process here, and it'll be interesting to see what happens in the future. But I guess I'd kind of hold back on any substantial conclusions on all this.

MEMBER KIRCHNER: Yes. We still are, we are a little bit ahead of the staff. Joy, you're correct. It's where we are today.

So I think Jose's point's been made strongly, and NuScale I know, of course, the staff can take notice of it. We are not in a position to draw out the Applicant's design fixes. We only can make our observations known at this point. And we should reserve judgement until the process, as you point out, is complete when the staff issues its SER, which we will do.

MEMBER BLEY: Right. I'd ask NuScale for tomorrow just to point out the specific language in Chapters 4 and 15 that you think covers this so that there's not a gap. But if you'd be real specific about that tomorrow, I'd appreciate it.

MR. BRISTOL: So one point of clarification, this is Ben Bristol, the event that we're talking about here doesn't include an ECCS actuation. It's an RSP that's cycling, and what PRA has identified is that CFDS can be used to flood containment and provide cooling to avoid the ECCS actuation. And eventually as the level increases, ECCS could be actuated on the containment level actuation. But this is prior to ECCS actuation.

MEMBER MARCH-LEUBA: Are you sure about that? Because the one, I mean maybe this, I'm at this slide is what you say. But there are three or four instances of this in Chapter 19. And one of them, the first one, is CVC has lined LOCA. So you have an isolated, the CVC has ejection line. Instead you lose inventory, and still you will open ECCS before you can find to turn CFDS. So maybe it's not this bullet was referring to all the other instances of the six like this in Chapter 19.

(Simultaneous speaking.)

MR. MELTON: Can you guys hear me okay?

MEMBER MARCH-LEUBA: Yes.

MR. MELTON: Okay, great. So we can address this further in the proprietary section. We have heard Jose's comments. We don't agree that the design is incomplete. And we think we have this covered pretty well. So we'll get to the proprietary section, but I think it would be fair to wait for that section so we can add some more detail and elaborate a little bit more. Maybe the design is complete.

MEMBER MARCH-LEUBA: Sounds like a plan.

MR. MELTON: Yes, that'll be our plan to carry this case a little bit further.

MR. BRISTOL: Okay.

MR. MELTON: Thank you, guys.

MEMBER KIRCHNER: Let's see, Matthew, are we back to you? Or are we still with --

MS. BRISTOL: This is Sarah, still going forward to Slide 16. And just to --

MEMBER KIRCHNER: Okay.

MS. BRISTOL: -- to clarify, I believe that we are talking about two different events. This event we're looking at in the PRA here is a beyond design basis event. It's an un-isolated containment.

And so, you know, we have common cause failure of things related to isolation valves to fail. So again, this is a beyond design basis event. We in the hearing credit power and credit operator actions, and so again, this is crediting the DHRS in order to give us more time to respond to the events. And that was one of the insights we got out of the updated thermal hydraulic runs.

MEMBER MARCH-LEUBA: Just talk about this in the process, okay?

MS. BRISTOL: Understood. Thank you.

Next slide please. With the PRA model we looked at, the ECCS fault tree model was reviewed to evaluate the potential impacts of the new ECCS actuation changes. So while there are numerous signals that actuate the safety logic, as in modeling simplifications, the fault tree logic does not credit all sensors and signals that may actuate ECCS. And so the existing credited sensor still remains adequate in that fault tree model.

In the initiating event evaluations, the PRA includes spurious openings of an ECCS valve as an initiating event. And since this new ECCS actuation signal would require three sets of sensors to spuriously actuate, the design change has negligible impact on that spurious ECCS initiating event frequence.

MEMBER MARCH-LEUBA: Sarah, I'm sorry to be the bad guy, but over a half an hour ago we heard that for the lower containment elevation set point of 252 inches to work, you needed to have credit for DHRS being on. Whereas in the previous calculations, any prior calculation, DHRS was not required to be activated. Do you update the sequence?

MS. BRISTOL: We did look at those in the PRA. We did update the levels and in the new actuation. So we did re-evaluate those sequences.

MEMBER MARCH-LEUBA: Yes, but you need to also require DHRS to be active. And I didn't see that change in Chapter 19. So what we were told, I mean what I asked is in the previous design SB LOCA calculation of the core, the actual level set point reference, what really triggered it was the IAB pressure.

And we're told that, well yes, that's because we didn't have any consent of the calculation, and we assumed DHRS was not working. But now, for 252 inches to work, DHRS must work. And that changes the sequences you may now have unaffected. But you do need to change it. Another thing to talk to in that conversation tomorrow, okay. Think about it.

MR. BRISTOL: Yes. And just to clarify, this is Ben Bristol, the LOCA progression we're talking about is a very small break where DHR is not a thing to function and ECCS actuates on the IAB release. So the actuation signal is generated, but the IAB has repositioned to block the actuation until the system depressurizes enough for the IAB release.

MEMBER MARCH-LEUBA: All right. And my question is that given the concern about liberating the downcomer and actuating ECCS RRV valves too late, have those sequences been incorporated into the PRA? You guys look at it, and tell me tomorrow.

MS. BRISTOL: Okay. Thank you. With respect to the success criteria, the event trees were updated to reflect the thermal hydraulic calculation results of the cycling reactor safety valves resulting in ECCS actuation, as well as the consideration of the containment removal system's delayed event progression to credit injection for those non-design basis un-isolated pipe breaks outside of containment.

We looked at the model queued for operator actions, and the time for operators to take actions remains unchanged such that the operator actions credited in the PRA were not impacted. Next slide please. The impact of the design change is limited to low likelihood sequences resulting in negligible change to the core damage frequencies, the large release frequencies. These design changes were seen well below the significant contributors to core damage and large release pressure. There was negligible change in the overall values presented in the FSAR.

MEMBER MARCH-LEUBA: I'd like to --

MS. BRISTOL: Yes.

MEMBER MARCH-LEUBA: -- go over those issues here. It's the bad guy again. I will say that it's not negligible change in the reporting for damage frequencies.

So Revision 4 reported a core damage frequency. And now we know that we require some modifications, because there could have been a problem. And we also know that the program was never evaluated. So we don't really know what the core damage frequency was for Rev --- we know what it is for Rev. 5.

So the numbers that we're reporting in Rev. 4 now do apply to Rev. 5 to fix this issue with ECCS. But probably the Rev. 4 PDF is certainly not 10 to the minus 11. And yes, putting it on the record, I would have liked to see the evaluation of the risk, because we always talk about risk in our evaluations and never do it. Keep going.

MS. BRISTOL: Okay. We did not have any additional candidate for risk significant structures, systems, components, initiating events, human action. And we were just discussing no change in significant core damage or large release.

These impacts, the impacts of the design changes in those subset of results were very low likelihood sequences, such that the first impacted subset was around tested 75, and it includes combinations of common cause failures with multiple data systems. And so these changes were, again, it's a low likelihood scenario.

There was negligible effect on the external events as well as zero power in shutdowns. And in these cases where the NuScale power module was manually shut down, for example, a refueling outage on a manual trip, the chemical volume control system remained available for cool down. We have power, we have operator actions, we have procedures, and we credit the operators to operate the plant, how they are required for tech specs and for their license.

And as the reactor coolant system volume shrinks, the operators adjust makeup and let down to maintaining natural circulation and shutdown margin with CVCS. And that is, you know, credited in the PRA.

And then in the postulated long-term cooling shutdown scenarios, there was a whole design change, maintains that re-circulation independent of operator action. So we evaluated that and did a low power shutdown as well. Next slide please.

MEMBER KIRCHNER: Sarah, did you look at the effect of not having availability of CVCS in that last set of scenarios?

MS. BRISTOL: On low power and shutdown?

MEMBER KIRCHNER: Yes.

MS. BRISTOL: In the various scenarios, we would look at CVCS not being available, yes, we evaluated that in the low power and shutdown.

MEMBER KIRCHNER: And did you see any marginal or market difference in results?

MS. BRISTOL: Again, with respect to crediting CVCS, it mainly used to, would end the PRA low power and shutdown to mitigate the incomplete ECCS actuation, such that if ECCS were to actuate we would have that natural circulation. And so it's scenario-dependent, you know, depending on the initiator if ECCS would be required or not. But CVCS is nominally available in the low power and shutdown PRA.

MEMBER KIRCHNER: Yes, we know that it is nominally available, but it's not implausible that it's out of service. It's a complicated system. There's a problem with a valve position. And since it didn't make the DRAP list, I'm just curious how you'd assign its availability or unavailability.

MS. BRISTOL: And I guess we would assess the reliability of the system, the two trains, the injection capabilities, the components in the injection line, and evaluated that in response to the event, and while that, again, makes the thresholds for candidates for risk significance, the importance of the operators to operate the system was important.

And so again, that action, you know, and that process of CVCS injection is evaluated in lower power and shutdown.

MEMBER KIRCHNER: Okay. This is just perhaps a personal observation from one member. I don't understand how it cannot be risk significant. It's such an important system in bringing the module to safe shutdown configuration that I'm a little nonplussed. You just said a moment ago that the importance of the operator intervention in the sequence, but the operator has to have a system that functions for him or her. Just one member's observation. Thank you.

MS. BRISTOL: Right. And in our analysis, we would see that the system is reliable. It's a very reliable system. However, the operator would be less reliable compared to the reliability of the CVCS. And again, it's an active backup system to the passive safety systems. You have to -- it's not required for safe shutdown of the module --

MEMBER KIRCHNER: Sarah?

MS. BRISTOL: -- in reactor sequences.

Yes?

MEMBER BLEY: This is Dennis.

MEMBER BLEY: Am I on? I guess I am. The last time I tried, I got a notice saying I'd been turned off.

CHAIR SUNSERI: No, you're on Dennis. I can hear you.

MEMBER BLEY: Okay. But three things I want to talk about. The first one is, I think it's more then a myth.

The language used in talking about these things, you know, is Chapter 15 kind of language. The PRA doesn't credit operators or credit systems, it includes the new model along with the evaluation of how likely they are to work under the situation we're looking at, number one.

Number two, I really agree with Jose on this one. This presentation keeps saying there was no change. That's very deceptive. What it really says is with this change in place, you find that the answers are about the same as they were when you didn't consider this scenario at all. That's a very different kind if, situation.

And third, I want to ask you about CVCS because it's been a while since I've read through details in the PRA. But we didn't get to see fault trees and talk about that.

With regard to Walt's questions, two things, is there a fault tree model for CVCS that is included in the PRA, number one?

And number two, if you had said the operator is important to initiate, was that just a single number stuck in for initiate? Or did you look at the sequence of things the operator has to do to align that system for different scenarios?

That's the end of my question.

MS. BRISTOL: Okay. Yes. So we -- it is correct, we have a fault tree model of the CVCS. And that includes operator action is in that fault tree model.

We do have that.

MEMBER BLEY: So, what is your action or is that a situation where you look at whatever valve line ups are required to be done for different scenarios of its use, and evaluate those differently?

MS. BRISTOL: We looked at the operator to start CVCS, and the higher level operator action. The valve where we did locate the design engineers, that's the valve in the path, the flow path.

Either, you know, failed as is. Or failed in the open position such that we could always have an injection path available to get inventory to the module.

And so, the operators in response to an event, do not, you know, need to do special actions in order to open up the line outside of potentially unisolating the module if it's an active injection, action isolation signal.

So, we credit the operator to unisolate and inject in that operator action.

MEMBER BLEY: As you talked earlier, you can inject into at least two places in the module that have different impacts on what's going on in some of these scenarios.

You didn't make that distinction. And that would require a different valve line up to switch where the injections go.

MS. BRISTOL: That's correct. And we did look at the different injection potentials from the PRA thermal hydraulic line.

If we had, you know, a break of the charging line alongside a continuum, we would credit the pressurizer spray line. And again, in the thermal hydraulic line, we potentially, you know, had a delay between transitioning from one to the other if one were unavailable.

And so we credit, you know, either path. And then again, the flow paths remain open, and then the operators in the control room are able to unisolate those isolation valves for whichever line they are planning to inject from.

MEMBER BLEY: Yeah. And this is a little more complex than the way it's modeled. But, that has to be at this point since you don't even have a procedure.

So, later on that should be, you know, have a little more detail on it by then.

MS. BRISTOL: Okay.

MEMBER MARCH-LEUBA: Yeah. In the defense of the applicant, these types of scenarios are based weeks the time cost, if not minutes. If not except for the plans positioned by an operator.

I will state that if any of these things happen in your committee, then we review worksheet and want to go out there. They might even have a walk through of the valves before they, to see if they line up properly. That will do it.

There really is on topic, and you heard Walt's every for the CVCS. Mine is CFDS. In the PRA, the person that's the DS is a backup for CFDS number one failure

MS. BRISTOL: In certain scenarios we do credit the containment flooding and drain system as a back up to CVCS.

MEMBER MARCH-LEUBA: When the staff is looking at your FSAR, try to remember how thoroughly we asked them if they checked those views. And they will have the issue of restarting CVCS -- because it's the ETS more for a week.

So, some things to look at. Is the only thing that's left. Okay. Everything else was fixed. The only thing that's still -- is in my mind, is that.

Everything else, we can think -- so, if you -- you know what I said. CFDS is my favorite one, and you will be on it.

MS. BRISTOL: Okay. Thank you. Next slide.

(Simultaneous speaking)

MS. BRISTOL: Okay. Thanks. Thank you. In summary, these design changes reflect the PRA results that we have in the FSAR.

We have updated event tree logic to reflect the new event progressions based on the design changes of the ECCS actuation and the event progressions for those effects.

And that's all I had. I think the --

MEMBER DIMITRIJEVIC: Sarah?

MS. BRISTOL: Yes? Hi Vesna.

MEMBER DIMITRIJEVIC: Hi. I was patiently waiting for time in here. But I've been patient, but so I have a very important question, but before that, I want to make a couple of statements to see do you agree with me.

Okay. The first statement, these boron scenarios have never been considered in the PRA. Not in the previous version of aspect, not in this version of aspect.

Is that a true statement?

MS. BRISTOL: Well, I --

MEMBER DIMITRIJEVIC: That doesn't say you have never had a failure to prevent, you know, the timely ECCS actuation, or what's happened after the wrong ECCS actuation.

Or what may happen when you're recovering from failure of ECCS, you have no any sequence in the PRA that addresses this problem. You did not have it before. And it's not now.

The changes which are made are just based on the change in ECCS actuation. Right?

MS. BRISTOL: That's correct. And then

the holes when --

MEMBER DIMITRIJEVIC: That is enter also. Or maybe -- or you also say that. But you have never considered boron an issue in the success criteria.

MS. BRISTOL: Correct. It does not lead to a core damage in the PRA evaluation.

MEMBER DIMITRIJEVIC: Basically you just assume that this is, the problem is improvement and it's not going to occur. Right?

MS. BRISTOL: Yes. We have addressed -- yes. With the holes we do believe that this boron redistribution issue is precluded.

MEMBER DIMITRIJEVIC: Okay. So, you have never looked in the small piece. And you have never looked in this, but it's also best to say you haven't addressed this issue in the PRA.

MS. BRISTOL: We looked at ATWS scenarios which have evaluated reactivity. So, it comes in the overall holistic.

We looked at, you know, the reactivity evaluations. Not necessarily from this, you know, specific scenario.

But, holistically, we looked at potential impacts.

MEMBER DIMITRIJEVIC: So, if this is why

you choose now not to look in this scenario after all of this come out, and you know, design changes are made. The reason you decide not to look in those scenarios at this moment is because you think that those holes, arise the holes totally for the vent in this event.

The many initiating events, the many situation that you have in the PRA. Is that a true statement?

Because if you are not -- if you think the ECCS actuates, you know, if you're not considering failure of the timing of ECCS actuation or the prolonged uses of recovery from ECCS failure, you think that recovery is addressed and it doesn't need to be part of the PRA.

Is that a true statement?

MS. BRISTOL: That is correct. We believe the design change addresses it. And we do not believe, we have no indication that the small amount would lead to a core damage.

MEMBER DIMITRIJEVIC: Okay. All right. So, that's I just wanted you, want you to state this on the record. That that has not been analyzed in the PRA.

And you don't see any failure mode which could lead to this issue. So, we can have a discussion because Walt brought in the beginning are you discussing the mitigation of conclusion?

And the thing that he asked is the sort of conclusion is considered not ending with mitigation on the way to fail is considering the PRA, right?

(No response)

MEMBER DIMITRIJEVIC: Okay. Now my other question is that the CVCS, the -- and I mean, I will come back with these questions, because I want to understand that what you are saying is true. And that there is no way we can get into this situation.

Now, the whole failure is prolonged ECCS actuation, right? And that did you guys ever look in the timing?

Did you actually look in any timing of the ECCS operation, either in the timing that doesn't actuate on time? Or the timing that operates for too long?

(No response)

MEMBER DIMITRIJEVIC: And what was the timing for the actuation when you put even the human actions for the actuator either charging or containment flood, what was the timing, how is the timing for these actions determined?

MS. BRISTOL: Depending on the events, we looked at various thermal hydraulic sequences. And then we would, you know, having different timings based on the plant site response unit to address that scenario.

MEMBER DIMITRIJEVIC: How about for best actions, you know, human error involved in the probabilities always the same, right? Because you assume that he has enough timing, or the timing is -- I was just wondering if this calculation of these humans, and what was the timing scale?

MS. BRISTOL: Yes. That's more of a numeric operator or higher probability for the operator action. We have a bounding approach to calculate those.

And so the timing was such that it was included in the calculations for that operator action at a higher level.

MEMBER DIMITRIJEVIC: What was the base, what was base for this timing? That's what I'm asking you. What was that based on?

MS. BRISTOL: We looked at the thermal hydraulic runs and looked at, you know, did we have enough time for operators to respond to the event to mitigate it.

And so --

MEMBER DIMITRIJEVIC: So you all had -- you have your own time of really, for example for LOCAs. Not the ones which assume that loss of offsite power is there.

So, ECCS will actuate in 24 hours or some. I mean, you have your own thermal hydraulic runs, right? Assuming there are offsite power is available. You know, things like that?

MS. BRISTOL: Yes. And we took a simplistic approach to modeling the human error probability in the PRA. Such that we put our most limiting times of 30 minutes, and just applying it across all of the events.

And we assigned that max human error probability for the shortest amount of time to all operator actions. Such that if there's an operator action and it cuts it, we just defined it the binding operator, the limiting bounding operator action timing and value, human error probabilities.

MEMBER DIMITRIJEVIC: And then let me ask you. And I mean, and I'm going to go and check for your importance of suggestion shutdown, because the low flow has happened. I don't remember how was this.

But when you determined importance of the systems and components, did you base this on the thought of CVCS? Or anything important in the shut down or for external events, or something valuable to be considered important?

What was -- how was importance based on the total CVCS? Or if any of the sections of CVCS is important it will be considered important? Like if it's important in shutdown.

MS. BRISTOL: Yes. We looked at each independent PRA and evaluated risk significant candidates for each PRA.

Such that it wasn't the overall CVS of everything. It was, you know, internal events we looked at, typically for suitability.

We looked at the shutdown. We looked at certain events --

MEMBER DIMITRIJEVIC: And you looked in the shutdown, you did not consider this, you know, the movement? Because that don't mean it's shutdown and maybe because of that, you know, maybe because of that nothing else was important in shutdown.

MS. BRISTOL: Well, we didn't actually take that approach. We did look at the internal events, low power and shutdown as well.

We kept the cranes separate. And we do

have risk significant candidates for low power and shut down in the FSAR. And CVCS and CFDS operator actions are candidates in that low power and shutdown table.

MEMBER DIMITRIJEVIC: All right. And if there were many, the important question for you, do you personally think that these events should be discussed in the PRA and addressed in PRA?

For example, if you have a vent which is very small, I think, you know, it's above your tech spec, but he fails to follow the tech spec, so you have a small leakage very likely, and no operator notices this for a long time, you can have a very, you know, specific event related to that.

Did you guys decided that this is events, you know, you are not planning to consider this event in the PRA?

MS. BRISTOL: I would say that we looked at this event through the issue of these small line breaks. We looked at tech specs. We looked at all of the operator actions that could be accomplished to mitigate these events.

You know, in you know, there's power, there's time, there's multiple systems. There's redundancy in the face of gaps in responding to this event.

And if you -- it does not seem feasible that, you know, and that's not how we're planning to operate the plant. To, you know, just let this event progress, you know, while we have numerous indications that there's something occurring.

You know, the PRA's best estimate and it's not using our model to, you know, look at --

MEMBER DIMITRIJEVIC: Yeah, I know all that too. Well, I just want to say that based on your CVCS out there, that is your first sequence. There is a million events in this PRA which are not very likely and satisfy everything which you cannot say.

And this is one very specific event, which in my opinion, exactly warrants consideration. Not maybe just for leakages, but for every situation when this, you know, the prevention may not work.

So, definitely you know, we are late now in the design specification. But definitely those events, someplace has to be designed for this in the PRA in my opinion.

But, okay. That's all from me.

CHAIR SUNSERI: Hey Walt, are we at a good breaking point here?

MEMBER KIRCHNER: I think you know, I'm

trying to remember how many more slides NuScale has. These are the changes. That's it.

Why don't we let them finish. And then take a break, Matt. I think we have to let people know that the staff is going to speak in an open session next.

And then the closed session is going to have to be pushed back. I understand that there are other staff members that need to be informed of when we would start that.

But, I would -- I would propose we have --

CHAIR SUNSERI: Well, Walt --

MEMBER KIRCHNER: On the open session of the staff's plans and public comment before we go to closed session.

CHAIR SUNSERI: So, let me just ask NuScale, how much longer are you going to need to finish this part?

MR. PRESSON: So, the next three slides, that's 21 and 22, are a summary of the design changes that we made and where they are captured in our licensing documents.

Then we have a conclusion on slide 23. So, I'd say maybe another ten minutes, plus questions.

CHAIR SUNSERI: Okay. So, let's take a

ten minute break here. Because nothing is going to happen in ten minutes the way we ask questions.

So, we're going to take a ten minute break until five after 4:00. So we'll reconvene at five after 4:00.

(Whereupon, the above-entitled matter went off the record at 3:56 p.m. and resumed at 4:05 p.m.)

CHAIR SUNSERI: Okay. This is Matt. We're going to reconvene. It's five after 4:00. I'll start with a roll call. Ron Ballinger?

MEMBER BALLINGER: Here.

CHAIR SUNSERI: Dennis Bley?

(No response)

CHAIR SUNSERI: Charles Brown?

(No response)

CHAIR SUNSERI: Vesna Dimitrijevic?

MEMBER DIMITRIJEVIC: Yes.

CHAIR SUNSERI: Walt Kirchner?

MEMBER KIRCHNER: Here.

CHAIR SUNSERI: Jose March-Leuba?

(No response)

CHAIR SUNSERI: Dave Petti?

(No response)

CHAIR SUNSERI: Joy Rempe?

VICE CHAIR REMPE: Here.

CHAIR SUNSERI: Pete Riccardella?

(No response)

CHAIR SUNSERI: Matt Sunseri. Okay, so --

MEMBER RICCARDELLA: Matt, I'm here. This is Pete.

CHAIR SUNSERI: Okay, Pete. You're back. So, one, two, three, four. All right. We barely have a quorum. So, let me just give us some remarks here and then we'll see if the others can join in here.

So, I know we have a lot of new information before the Committee. And therefore, we're asking a lot of questions. And that's inherent in our process, and we need to allow members to ask their questions and get their answers.

So, I was looking for an opportunity to take more time for breaks during that. But, I did not want to discriminate against any member and give them their fair time to ask all their questions.

However, saying that, we really need to look for an opportunity about every hour or hour and a half or so, to have a break. It's just too long to go two hours on these Skype sessions without being able to stand up and get up and refresh our brains.

So, I ask all the members and participants to help me with that, to look for these opportunities. So, before we just go on then, I'll just check with the others.

So, Dennis Bley, have you joined us?

(No response)

CHAIR SUNSERI: Charles Brown?

(No response)

MEMBER MARCH-LEUBA: Jose is here.

CHAIR SUNSERI: And Jose is here. Okay. How about Dave Petti?

MEMBER PETTI: Yep. I got knocked out right at 2:05. And I'm back.

CHAIR SUNSERI: Okay. So, we're just missing Charles and Dennis.

MEMBER PETTI: I think what's happening is that when I go to the Microsoft portal, and you don't do anything for a while, it automatically logs you out. And then it kills Skype for Business as well.

I'd like the staff to think about that.

MEMBER KIRCHNER: Well Dave, one thing I've been doing that has worked very well, whereas I know some of our colleagues have been knocked off frequently, and that is I'm going through the normal VPN connection. To Skype on my NRC computer.

And I actually, it's been pretty much

faultless. I've only been dropped once, I think, in the last several meetings.

And even though it's inactive during the lunch break today, it stayed on. It didn't sign me off or break the Skype connection. Just an observation.

CHAIR SUNSERI: Yeah. Okay. So, is Dennis back with us yet?

(No response)

CHAIR SUNSERI: How about Charlie Brown?

(No response)

CHAIR SUNSERI: Okay. Well, we have eight out of the ten. So, I'm going to turn it back to Walt. But, before I release it, I mean to impose a hard stop here at 5:45.

And that's if we make it to the closed session, fine. If we don't, then at 9:30 tomorrow, we will resume the foundation discussion per our agenda.

At 5:45 though, I need to stop. And we need to move on with the finalizing our comments on the Reg Guide 1.236 report.

So, that gives us about an hour left at the very end of this day to do that. So, we will end this NuScale, we will recess with the discussion on NuScale at 5:45.

So Walt, take it from here.

MEMBER KIRCHNER: Okay. I think we're back to Matthew Presson. And I think they have about three slides left if I remember correctly.

So NuScale, go ahead. Whoever is going to take this next session.

MR. PRESSON: Thanks Walt. I appreciate it. This is Matthew Presson. And we will be starting back on slide 20, where we cover DCA and conforming changes.

Essentially describing the three very focused changes that we had. But since the FSAR and the rest of the DCA are very involved licensing basis, there are a number of places where those changes showed up.

So, to help us go through that summary, Paul Infanger will be presenting on these slides.

MR. INFANGER: Okay. Checking my microphone is unmuted.

MEMBER MARCH-LEUBA: It is unmuted, Paul. Can I ask a question about process? So, we have issued or you have issued an errata two.

So, the process would be the staff reviews all these, all these on these pages. And then they issue an SER, at which point you then will issue revision five?

MR. INFANGER: Yeah. That's correct.

MEMBER MARCH-LEUBA: All right. Thanks.

MR. INFANGER: So, we made the whole middle to document and update the application for the design changes and the analysis changes that we've made.

We submitted the DCA Revision Four, errata two on May 20. And it would affect a number of various, so we just kind of are summarizing the various sections and what changed.

For example, in Tier One, Chapter Two, it lists the ECCS actuations. So, since we added a new actuation spindle and set point, that was added to this at Tier One, Chapter Two.

In the FSAR itself, there were a number of changes where we were describing the modifications themselves. And then did some conforming changes to document the interrelation between some of the sections now.

So, the rise in all and structural evaluations itself were in Section 3.9 and 5.4. And the new ECCS actuation, the data box, which contains the pressure and the YAR, I mean, the YAP, any of those if this point changes, both the new part ECCS actuation signal and the containment level revision.

And the passive valve opening, I would feature that was, it's always been there with the valve, but we add it to the description section in 4B and for the 15 fix.

And then also the, there's a change in the RCS wide rate pressure instrumentation, because we are now using that for an ECCS signal. So, it was upgraded in the DROC program.

But, that affected the Chapter 2.2, 6.2,6.3, 7.1, 7.2, 15, 15.6, and 17.4. So, that was pretty wide, widespread throughout the FSAR.

We added the, to Jose's point about the mechanisms of the solution in the downcomer. Since that was a new phenomenon, we described that in Chapter 4 as a potential issue for boron dilution.

And so we described how the -- that there's a potential either from containment, because you -- in any steam place break, you're going to end up with unborated water in containment.

And then there's a couple of mechanisms for getting, either in LOCAs or DHRS events, when the riser becomes uncovered, or goes to the levels below the top of the riser, you can start to get condensation in the downcomer.

So, those phenomena were described in Chapter 4. And then in Chapter 15 we put a reference to the sections that say that the --that the potential for solution during restoration needs to be considered.

And there is a section, in Chapter 13 we have procedures that are required to implement the requirement of Reg Guide 1.206, which includes details on what you have to be in operative three that's including restoration from a severe event.

The LOCA analysis was changed to mention that earlier in 16.65. Some tables and sequence of events and some minor changes to results.

And then we updated the PRA event sequences to the new actuation signal. And descriptions of the riser holes in Section 19.1.

The ECCS signal is a stipulated actuation. It is a separate item in the technical specifications. And then we added information in the instrumentation section and in the ECCS section and the associated basis for those tech specs.

The next slide. We also stated the number of technical supports, the instrumentation step point methodology, we added the ECCS signal and the actuation range discussion.

The advanced sensor technical report, we added the same information. For the containment it was part analysis. We did the evaluation of -- we verified that the limiting cases for containment of peak pressure and peak temperature will remain unchanged.

And we noted that there were some minor changes to the nonlimiting cases. But we verified that they remained nonlimiting and that we didn't update the nonlimiting cases in the containment technical report. But did document that they were evaluated and will remain nonlimiting.

And the alternate cooling methodology, we added the new ECCS signal. And discussed that the long term cooling evaluation will remain acceptable.

It did not change the limiting cases for the limiting, or for the long term cooling. And then there was just minor change in the tech spec technical report to document the change to the ECCS.

And just one other item we're just noticing there will be probably for discussion more throughout the meeting of most of the changes that we've been in discussion with the staff were complete.

And we submitted in our FSAR update on May 20, and they were admitted and there were just a few topical reports we updated that we sent a week later.

But there's still one issue we're discussing with them, and that's the basis of our GDC 33 exemption and makeup. We'll have a thorough discussion so we don't have anything to report on that. So, I just wanted to mention that for completeness.

And next slide. And then on the topical reports. Similar to the containment section report, with LOCA we evaluated the limiting cases.

The new ECCS actuation set point did not affect any of the limiting cases. So, we added the information that that set point is there.

But that we didn't have to revise the limiting analysis or the limiting case selection. So, there's no change to the MCHFR limiting case or the class liquid level above that active fuel case.

So, those things are noted in the methodology. And then we verified that all the nominating cases remain nominal.

And the LOCA is non-LOCA topical. We really just added a note saying that the ECCS actuation signal was in the riser holes, had been added.

But, this, in the non-LOCA topical,

there's no actuation of ECCS. So, that was a pretty minor change.

And the riser holes simply maintain a function that we were making previously on boron distribution.

MEMBER MARCH-LEUBA: Hey Paul, can we go back to GDC 33? Are we going to be hearing any more details about that?

MR. INFANGER: Not in this presentation. We were still, I'd say it's all predecisional. We -- one thing that's a little different in the revision we sent on May 20, and then the topical on May 27, is we discussed the changes with the NRC staff in detail prior to making the submittal.

Because, it would be a compressed, the time schedule. You know, they can't do preapproval obviously.

MEMBER MARCH-LEUBA: Sure.

MR. INFANGER: But the changes we made to the FSAR were all discussed with the staff in the audit. This current audit was --

MEMBER MARCH-LEUBA: This wasn't the --

MR. INFANGER: Going on since that and just daily meetings. So, we've been putting information in, in an electronic reading room.

And this relates, we don't want to have to iterate with the staff. But, there were a couple of things that we're still finalizing with the staff. And this is the GDC 33 content is one of them.

And we're going to be proposing another small addition to the FSAR. But again, we don't -- we haven't -- everything else we are presenting here has at least been discussed in detail with the staff.

And then that part is, I would say, still, is still an active subject.

MEMBER MARCH-LEUBA: Is there any serious technical issue? Or are we just trying to document what we agree on?

MR. INFANGER: Yeah. The essential issue is simply that we don't rely on makeup to meet GDC 33, which is, most plants use the normal makeup system.

And we credit the ECCS system to handle RCS leakage. And we're just talking about where we defined the difference between an RCS leak and the LOCA design basis spectrum.

And how we handle the analysis in those two different regions.

MEMBER MARCH-LEUBA: We're looking more as a combination then as a real approach.

MR. INFANGER: Yeah. It's not going to

require any other changes. It's simply how we document the basis for the exemption to GDC 33.

MEMBER MARCH-LEUBA: Yeah. I mean, because a tech spec leak geek, less than .5 pounds per minute, you handle it with CVCS with no problem.

And but if you don't have power because it's not safety grade, then how will the containment handle it with ECCS?

I don't see -- you just have to demonstrate and run the calculation and make sure that you satisfy all the requirements, all the conditions.

All right. Keep going.

MR. INFANGER: Okay. With that, I think I'm done. Matt, do you want to go live?

MR. PRESSON: Yeah. So yeah. For the summary and conclusions. I wanted to cover that our design changes were selected and chosen specifically that were on redistribution for those postulated design basis and beyond design basis events.

And focusing on those design changes, we adjusted our ECCS actuation to, well, we added a new ECCS actuation signal on low RCS pressure. And adjusted our high containment level set point.

And with the combination of those two, we assure that the initial flow out of our reactor pressure vessel would preclude an influx of unborated water from the containment or downcomer.

The third design change that we incorporated was the addition of riser holes. In order to assure boron mixing in the downcomer and core, and the specific cases that we looked at there are when, for when PSRS cools and shrinks the RCS level below the riser.

And for those smaller LOCAs and RCS leaks, while the RCS level is above the holes. So, throughout that work, our analysis has demonstrated that no significant changes to the results that we see in the previous, well, the January 4, January Rev. 4 and that our acceptance criteria continue to be met.

And the last bullet on this is simply covering that while we did look to select and stayed very focused with those design changes, the evaluation and resolution of this topic has involved an evaluation of a large scale-postulated scenario, along with a sense of calculations, reviews, analysis, and related document changes that were all developed to implement the -- implement these design changes.

Essentially looking to ensure that while these are three quote/unquote small design changes, that they are effective at what they do. And that we have a broad enough evaluation of those changes to ensure that nothing else would result from making them.

So, --

MEMBER DIMITRIJEVIC: I have a question.

MR. PRESSON: Yes?

MEMBER DIMITRIJEVIC: Are these diag -- these ECCS concentration and riser holes, are those design changes all or ending? Are they both necessary? Or either one of them will preclude this influx of unborated water?

MR. PRESSON: For the couple up there?

MEMBER DIMITRIJEVIC: Yes. Yes, my question is, if you made the two major changes, why do you think ECCS actuation set points and another is riser holes, right?

MR. PRESSON: Um-hum.

MEMBER DIMITRIJEVIC: So, my question is, are the both of those design changes necessary to prevent the influx of the unborated water? Or either one of them is enough?

MR. PRESSON: So, to answer that, those first set of changes for ECCS actuation were the kind of primary lead in design changes that were targeted as resulting in these postulated events.

And then we looked at riser holes in order to increase the margin that we saw for DHRS operation. So the riser holes are more based on ensuring that we have adequate margin for all those postulated events. While the ECCS actuations were targeted at actually precluding them.

MEMBER DIMITRIJEVIC: Well, I don't --

MS. BRISTOL: So, to answer your question Vesna, both are needed. Both changes are needed in the design.

MEMBER DIMITRIJEVIC: Because I just discussed it better that which one was adjusted. I make the call provided not missing to preclude this influx.

So, because ECCS actuation, you know, will fail, can fail. And you know, can occur in wrong timing.

So, therefore, my question is, if we don't have an ECCS actuation in the right time, do we still have a problem? Even if we do have the riser holes?

So, my question is, if ECCS doesn't actuate on the right time, which we don't know about these things exactly. But let's say if ECCS doesn't actuate on the right time, do we still have an issue with this influx of unborated water?

MS. BRISTOL: When we looked at the different ECCS actuations before this new proposed actuation and reflected that in the PRA, you know, in the historic runs as well as the new set points now in the TH run.

And so, we can discuss the specifics of those PRA, TH results in the closed session, if we can bring that back up, Vesna.

MEMBER DIMITRIJEVIC: All right. Okay. But my question was simply enough. You know. My question was, if the ECCS doesn't actuate, with the PRA in the event, would those holes prevent this event? That's a simple question.

MEMBER BLEY: Well, it's probably not so simple Vesna, as that. Earlier, and I forget which of the gentlemen in the first presentation, said they'd done some calculations of, thermal hydraulic calculations best estimate with uncertainty.

And I'm guessing that's something like a CSAU approach. And most of the times things are okay. But not all of the time.

So, I don't think they can answer that definitively. Or haven't tried to. If NuScale disagrees with that, step up.

MR. BRISTOL: This is Ben Bristol. I

would say that the riser holes actually are quite effective for mitigating the redistribution for both the DHR cool down scenarios and the slower LOCA event such that the timing of ECCS, if the holes were to uncover that's when we would postulate that the redistribution would start to occur.

And the ECCS actuation at that time is much more preferential for precluding a core in surge type phenomena, or at least the phenomena we were looking at.

MEMBER BALLINGER: Yeah. This is Ron Ballinger. So, there is no scenario in which the riser holes do come uncovered?

MR. BRISTOL: Yes. Normal ECCS operation, the riser holes are well in the steam space.

MEMBER BALLINGER: Okay.

MR. BRISTOL: So, they're not relevant once we get to normal ECCS cooling conditions.

MEMBER BALLINGER: Okay. Thank you.

MR. BRISTOL: Sure. One other clarification. I think, with respect to the credit of CFDS in the PRA, I think it's important to understand that those are event sequences where we would expect the core inventory is unmit - the inventory loss is unmitigated. And we're progressing toward a full on recovery condition.

So, the credit of CFDS is -- and the inventory addition, is definitely more beneficial for the core, with the acknowledgments of the challenges of where the boron is, and how CFDS impacts that. Keeping the core cooled is the primary consideration for those extreme beyond design basis events.

And that's a lot different than what our restart procedures might be. And again, we don't have those, and they're not developed at this stage. It's a design certification.

The restart procedures will all ensure that CVCS is used in order to reestablish a safe boron concentration in the system when coming out of, or restarting from an extended ECCS operating condition, core event.

MEMBER MARCH-LEUBA: Yeah. My point is that you have to also do scenarios and analyze each one. There's always one outlier.

And this if your core is getting uncovered, you want to put water. But you don't want to put unborated water.

So, my point is, somebody has to think about it, and analyze it. And figure out if it's good or bad.

MR. BRISTOL: Sure. And we definitely would prefer to put unbor -- to put borated water at all times in the PRA because of the failure sequences.

There are times at which that is not possible, right. And that's where the analysis of CFDS comes into play.

MEMBER MARCH-LEUBA: Okay. Let you go.

MEMBER KIRCHNER: Okay. Matthew, is that it for your open presentation?

MR. PRESSON: Yeah. That's it for the presentation. I did want to capture a quick follow up from one of your requests earlier on kind of the diagrams for CVCS.

I wanted to point you towards Table 7.1-5 with the description of containment through dash 1 overrides. That kind of covering some of that information, as well as figure 7.1-1k.

And then also figure 9.3.4-1. Actually it shows the three distinct lines into containment that are provided by CVCS and the valves that are attached to that.

MEMBER KIRCHNER: Okay. Thank you.

MR. PRESSON: Yeah.

MEMBER KIRCHNER: Okay. Members, any other questions that -- hopefully we could defer further questions at this point to the closed session. So that we can transition to the staff.

But, I don't want to silence anyone. I'm going to use the 15 second rule.

(No response)

MEMBER KIRCHNER: Okay. Hearing no further questions, thank you, Matthew and your staff for the presentation.

And we'll need a few moments here now to make a transition to the staff. And Mike Snodderly, would this be Bruce Bavol, or --

MR. SNODDERLY: Yes. Yes.

MEMBER KIRCHNER: Right now would -- you're going to make an introductory comment.

MR. SNODDERLY: All right. What we're asking if Bob Caldwell or Rob Taylor, if they want to make an opening statement. But I know Bruce Bavol will be the presenter.

So, please Bruce, request to share your screen. So we'll get started.

MEMBER KIRCHNER: Yeah. Bruce, I'm just going to turn right to you.

MR. BAVOL: Understand. I'm ready to go. But, if management needed to say a few words?

MEMBER KIRCHNER: Okay.

MR. CALDWELL: Hi, this is Bob Caldwell. And I think we're ready to get started. And let's go.

MEMBER KIRCHNER: Okay. Thank you, Bob.

MR. BAVOL: Okay. Again, this is Bruce Bavol. I'm a project manager for the NRC. I'm currently working on the NuScale design certification.

This is a project presentation. It will go very quickly. All on the open item update and what staff has been up to over the last several months.

On slide two I have a short agenda here. Talk a little bit about the April 29, ACRS full Committee letter, which led us to set up these meetings and a future July full Committee meeting for staff.

We'll give you a little background on what got us to this point. The design changes, I won't spend much time, because NuScale did a good job in explaining those.

Impacted Chapter SCRs, along with technical topical reports, again, NuScale provided that information. And of course the next step in what staff is going to be doing here in the near future.

Slide number three. I think the key point here for the ACRS full Committee letter, our response back was that there were two bullets on number two.

They're trying to put a criticality maintaining that item throughout the audit. And our future description, or our future presentation with the boron redistribution and the issue that remains open.

That's really why we're here today. And then again, in July for the staff presentation.

Slide number four. A little bit about the background. February 27 the error in the boron redistribution analysis was pro -- that information was provided to us.

On March 2 staff initiated an audit plan. We got things going pretty fast. On March 4 we held an audit entrance. So, as you can see, we've been at it for quite some time.

And the first staff sent the letter, schedule letter to NuScale. And this is because some of the items were going to be interrupted. Some of the milestones, mainly the ACRS schedule.

But, what we're looking at once we get the full Committee presentation, we'll be able to proceed with the letter writing and the DCA Rev. 5. And then we're also shooting for that phase six milestone in September.

On May 20 as was presented by NuScale,

that second update to DCA Rev. 4. There are a number of items were put on the docket.

I'd also like to make mention that we've done pretty much daily audit briefings, status briefings. And we've held multiple public meetings.

In fact, the last public meeting we held was Monday, June 1. All this information is, summaries are being put together. But, we have information from -- that's being placed into ADAMS.

So, moving on to slide number five. These were the design changes that NuScale provided the technical, all nonproprietary discussion.

But also, I'd like to make mention that we applied the chapters that were impacted by the specific design changes, which we need to make sure that the technical dif -- or technical disciplines are involved.

And we coordinate all that information to make sure we don't miss something as we go along. And something doesn't drop through the cracks based on what we've been provided.

On slide number six here's a list of the chapters that staff have gone through. Either that a change was made, it was provided, the change, the redline strike out was provided by the electronic reading room.

This is our audit base for all documents and calculations and such that the staff is using for the audit, along with various Skype meetings and audit status meetings.

And again, the impact that the topical technical reports that were again mentioned by NuScale. And the technical reports of course support the chapter, specific chapters, if there were changes there they were written about in the safety evaluations of the specific chapters.

Again, this is it. This is the last slide here. We're currently completing analysis. And we want to, we will be engaging the ACRS in a technical briefing of the staff findings in July.

I believe July 8 is what I've been hearing. But, I'll wait for ACRS staff to give us a final.

But, what I'd also like at this point is, since this is a little different where staff isn't going to be briefing until July, if there's anything from the ACRS members that came up during the NuScale briefing that you would like to inquire about from our technical staff, I'd like that to be, you know, discussed either here or in closed session as needed.

So that our staff, who most of them are on the line, can hear and prepare a better presentation. And that's all I have.

MEMBER KIRCHNER: Thank you, Bruce. Let me turn to members then. Do you have any questions or requests of the staff that you would like to air at this point?

MEMBER MARCH-LEUBA: Yes. More of a response to the last comment. Often we've written a white paper with our concerns.

And maybe the Committee will do something like this and give you some topics in writing for you to address in that presentation.

MR. BAVOL: Okay. Thank you.

MEMBER KIRCHNER: Bruce, this is Walt Kirchner. I have one item. With regard to the topical reports on methodologies. I'm just going to ask a leading question. I don't require or need an answer at this point.

Are you going to, the staff, are you going to look at the applicability of the RELAP code for analyzing the flow through the holes that now have been put in the riser design to mitigate the boron dilution problem and the downcomer?

And I'll just make one observation from my own experience with these kind of numerical methods that one often has a problem with numerical defusion exceeding natural physical diffusion.

So, I would be interested in the staff's review of the applicability, the methods for analyzing that particular phenomenon in the downcomer. The mixing from the riser to the downcomer.

MR. BAVOL: I understand those questions. That's exactly what we were looking for. We have Reactor Systems staff observing today's session.

So, I'm sure they're, you know, taking that information down.

MS. PATTON: Yes. This is Becky Patton from Reactor Systems. And we'll be sure to address that when we come in July.

I think some of the details for how they do that are likely proprietary. So, and the staff is still also currently reviewing how they performed that analysis.

MEMBER KIRCHNER: Thank you, Becky. Yes, and then obviously the methodology and then the actual analysis, the bounding analysis so that we can demonstrate confidence that the dilution problem is actually physically solved. Thank you.

VICE CHAIR REMPE: Walt, this is Joy. I

had a couple of questions. One, has the staff gone through the review enough to say that the middle is complete? Where exactly are you in this review?

And then secondly, could I ask for some elaboration on what's going on with GDC 33? Some more to the question that Jose asked? Because I'd like a little more understanding of what's going on in that topic.

MS. PATTON: So, this is Becky Patton again. So, as to where we are in the review, we are partially through the calculations.

So, it's really premature for me to report back on aspects of that review. And I also, as I think NuScale may have stated in their presentation, we are still discussing some aspects of GDC 33 with them, and their exemption request, and the analysis they perform for that.

So, I guess I would prefer to report back on that when the staff provides its detailed presentation in July. But, we are planning on having a presentation of those aspects.

VICE CHAIR REMPE: So, with respect to schedule, do you have a feel for when we're going to receive all this information? The draft SE from you, et cetera?

MR. DUDEK: Yes. This is Michael Dudek. So, I think with respect to that and our coordination and collaboration with Mike Snodderly and Scott Moore, I think preliminarily we have discussed giving you the completed SER and the final products by June 26.

MEMBER KIRCHNER: Joy, that's my -- this is Walt. That's our understanding, Joy, on the --

VICE CHAIR REMPE: Okay. I just wanted to check again. But, thank you.

MEMBER PETTI: Walt, I have a question.

MEMBER KIRCHNER: Go ahead, Dave.

MEMBER PETTI: Can I ask the staff about, and if they can't answer now, certainly when they come to us in complete, in July.

How does this information that we're going to hear in closed session, get documented? Where does it get documented in the process?

Because nothing that we've been given so far has any of the details except these slides that we're going to hear about in closed session.

Does the process require that they be documented in some other way then what we've received so far?

MR. BAVOL: This is Bruce Bavol, the Project Manager. Currently, as the audit progresses, our process requires that we generate an audit summary. Which is going to be an extremely detailed review of what the staff has looked at, broken down by technical disciplines.

And we've been maintaining an ongoing summary. And staff has been adding to that as we've been going along.

So, yes. The goal is to get a summary generated that would complement the completion of the review.

MEMBER PETTI: But there's not a NuScale document beyond this level of slides that we're going to see?

MEMBER MARCH-LEUBA: Bruce, do they have a reading room where all the general calculation sheets and documents are available to you? For the audit?

MR. BAVOL: Yes. So, currently in the audit process we've got an electronic audit reading room. And applicable documents are placed in that room, just like a regular audit, calculations and so on.

And staff have access to that. So, that's really the interaction we have with the audit process. And of course, if a document is changed in the DCA, a chapter is changed or a technical report, topical report, that information is provided, will be submitted with that change, ultimate change intact when the audit is complete.

MEMBER KIRCHNER: I think our issue, Bruce, has been that the FSAR is more description than rationale of changes that they've effected to the design.

It's -- probably of more underlying interest is the analytical support for these design changes. That's of interest.

So, I think that's the, at least the spirit of our questions.

MEMBER MARCH-LEUBA: Yeah. But all that information is contained in the electronic reading room on our internal engineering data files for, from provided from NuScale.

And they're made available to the audit team. But, they are not part of submittal. They don't go to ADAMS.

Now, ACRS can beg and ask the question with immediately go to the reading room. But, be careful what you ask for. Those things tend to be hundreds of pages long. I would love to.

MEMBER PETTI: Jose, I just found it

interesting that the topical reports were incredibly detailed and calculated every sequence noted, as just demonstration of how many of them were exactly what is reported in the FSAR.

And so I was surprised that something as important as this doesn't rise to the level of another appendix in one of the topical reports. It's just --

MEMBER MARCH-LEUBA: It should have been a topical report for review independently. We just didn't have the time.

But, this is something --

MEMBER PETTI: I'm just wondering if it's in the software.

MEMBER MARCH-LEUBA: It's not unusual. They -- NuScale works under Appendix B. And everything that calculates has to have a report underneath, signed by two people.

And they make all those papers available. And they're hundreds of pages long. And that's how the staff does audits.

Unfortunately we at ACRS have to read the FSAR which says, we put some holes. And believe me, it looks good. That's all they give this.

But, I have good confidence that, I mean, there are hundreds if not thousands of pages in that reading room with all these calculations.

And hopefully the staff is looking at them.

MEMBER PETTI: Okay. I stand corrected.

MEMBER KIRCHNER: Other members, questions, comments, suggestions for the staff?

(No response)

MEMBER KIRCHNER: I guess I had one that I'll suggest. And it goes back to the very beginning of the NuScale presentation and then again at the end with Vesna's comments on PRA.

The whole approach is one of precluding the event sequences that we're worried about. And that's to be complimented.

The question though is, if one is not successful, what are the consequences? I don't know that we've seen any analyses showing if you do indeed have a diluted slug of cold water injected in the core, what are the chance or consequences in terms of core damage?

MEMBER BALLINGER: Hey Walt, this is Ron. That goes to the point where I asked about the why question.

And that's something that I think you asked as well, right? With the holes for example.

MEMBER MARCH-LEUBA: Well, they showed us -- they showed us last month an AMC and P calculation of a front, or they're worried if I'm moving into the core, at which point does it get to criticality?

And probably the results are not proprietary. And I cannot tell you what elevation. But, it showed that you risk criticality with plenty of room to spare.

So, the calculation is not difficult to do in your head. If you're able --

MEMBER KIRCHNER: Yes. But that's an idealistic calculation as well. Maybe this is a conversation to be held with the staff offline.

MEMBER MARCH-LEUBA: Or on the question of --

MEMBER DIMITRIJEVIC: This plans to the whole thing. What I was trying to reach with the PRA. What the sig -- what if we have scenario, a simple scenario, then you have a look and we discuss the size.

And then we have a failure of delayed ECCS actuation. Where that would lead? So we have to define, what is the delay?

How long is the rack, has to be uncovered to bring to the problem? And things like that. This analyzing doesn't exist anywhere.

So it's a simple scenario, LOCA and failure of delay in ECCS actuation. That's it. What's happening with this?

MEMBER MARCH-LEUBA: It also depends on the size of the LOCA and how long it took to get that there.

And there are thousands of scenarios or combinations.

MEMBER DIMITRIJEVIC: Right. Right. Well, you know, the delay is defined differently for different size of the LOCA.

But the question is that my impression was that this manual would never lead to problems if we had the whole rise. Of course this is definition of the failure of the ECCS penetration, which is easy to understand how it fails.

Now, we cannot really look in the failure of the holes, right? So, that's not the questionable. But, I think that --

MEMBER MARCH-LEUBA: Yeah, NuScale -- NuScale answered that question for you half an hour ago.

If you have a LOCA, for the first six seconds or minutes, you are -- your level is higher than the holes. And the holes are effective in mixing boron.

Eventually you're going to drop your level below the holes. And continue to drop it. At that point, you're starting ready.

The question is, how long are you going to be before you open the ECCS valves? So, you have to do a balance of is the ECCS working or not working?

How large is the break? There are so many combinations. But, the holes are in the middle of the steam generator. It's roughly 10 to 15 feet above the level that you reach when you open the risk, so.

MEMBER DIMITRIJEVIC: Yeah. But my point is that these calculations have not been performed. That those calculations, how long, lots of situations has not been performed.

Even staff assumed that these preventions will not fail. And then we are fine.

MEMBER MARCH-LEUBA: No. They have not been performed. I assume, I haven't seen the PRA. But I assume that if this fails, if the ECCS opens late, you can see that it fails.

MEMBER DIMITRIJEVIC: Yes. But then you know that there was just from some reason the PM didn't analyze any of those failures. There was no risk involved in applications.

So, then these risk scenarios are not in the PRA. So, they're not in Chapter 15. They're nowhere.

MEMBER MARCH-LEUBA: No, but this is a LOCA scenario. Anyway, I agree with you, the calculations were not performed. And that's how we've seen them.

MEMBER KIRCHNER: Okay. Any further comments from members?

(No response)

MEMBER KIRCHNER: Okay. Mr. Chairman, it's about four minutes before five o'clock Eastern daylight time. We can take a quick break.

Would you -- and then --

PARTICIPANT: Public comments, please?

CHAIR SUNSERI: Yes. Please, we're controlling the meeting. Yep. Go ahead Walt.

MEMBER KIRCHNER: And we can start on the closed session. And you've declared a hard break at 5:45.

And so, I think it's -- we'll have to sign off this open Skype line.

CHAIR SUNSERI: I think before we do that, --

PARTICIPANT: Public comment, please.

CHAIR SUNSERI: Yes. We've got it covered, please. Before we do that Walt, we're going to have to -- we're going to offer the public to --

MEMBER KIRCHNER: Yeah. Public comments. Thank you for the prompt. Thanks.

CHAIR SUNSERI: And I would ask for the public line to be open.

MEMBER KIRCHNER: Open the public line, please.

OPERATOR: The public line is open for comments.

MEMBER KIRCHNER: Okay.

MR. LEWIS: Yes. My name is Marvin Lewis. And I demand to have a question now.

MEMBER KIRCHNER: Go ahead, Marvin.

MR. LEWIS: Hello?

MEMBER KIRCHNER: Hello.

MR. LEWIS: Oh, thank you.

MEMBER KIRCHNER: Go ahead.

MR. LEWIS: Okay. So, here's a simple question. The question I have had for 30 or 40 years presented to the staff, Commission, what have you, again and again.

Say you have a LOOP, a loss of offsite

power. And the whole place is without power, so you can't heat up any of your borated water tanks or anything like that.

And it actually gets to the point where the flow rate precipitates from the water. Which happens when the water gets cold.

And once it's precipitated there, it's a bugger to get back in. It doesn't go back in easy. Have you looked at that situation?

Again and again I've asked if this situation has been looked at. And I've got a very limited answer. Thank you.

MR. KIRCHNER: Thank you, Marvin. Any other members of the public wish to make a comment, please --

MS. FIELDS: Yes.

MEMBER KIRCHNER: Go ahead.

MS. FIELDS: This is Sarah Fields. Throughout the numerous discussions around the NuScale design, you go to various scenarios that will need operator attention and options.

And some of these options have not even been identified yet. However, NuScale is in the process of developing a topical report where they're requesting a -- the possibility of the use of operator workers in the control room.

So you would have one operator and a couple of senior operators. So, already, even though the SCS is, this is in anticipation of a standard design approval application.

Which will really supplement this ST. I mean, yeah, the design certification. So, considering the unresolved issues related to this current application, I am very surprised that NuScale would want to reduce the number of control room operators who would be responding to these types of LOCAs or non-LOCA events.

So, that's my comment. And thank you very much for the staff and ACRS' hard work and consideration of these issues.

MEMBER KIRCHNER: Thank you, Sarah. Is there anyone else out there who would like to make a comment? Please state your name and comment.

(No response)

MEMBER KIRCHNER: Okay. Mr. Chairman, I think that was 15 seconds. I hope that was adequate for any other additional public comments.

I haven't heard --

CHAIR SUNSERI: Okay. Thank you, Walt. And thanks to the public for providing your thoughts on this matter.

Mike Snodderly, is this still the case that we need 15 minutes to transition into the closed session?

MR. SNODDERLY: No, Matt. I don't think so. I think we just end this call. And hopefully everyone has an invitation from me from 3:00 to 6:00 p.m.

And just go accept that invitation and we'll get started as soon as you have a quorum and we have the NuScale and the staff on the line.

So, why don't we give it a shot?

CHAIR SUNSERI: Yeah. Okay. So, let's transition over. And everybody get their Skype line up and we'll reconvene on the closed session at 15 after the hour. So, 5:15.

MR. SNODDERLY: Thanks.

CHAIR SUNSERI: All right. Thank you all. And so we are recessed to the closed session, moving into the closed session. Thank you.

(Whereupon, the above-entitled matter went off the record at 5:02 p.m.)

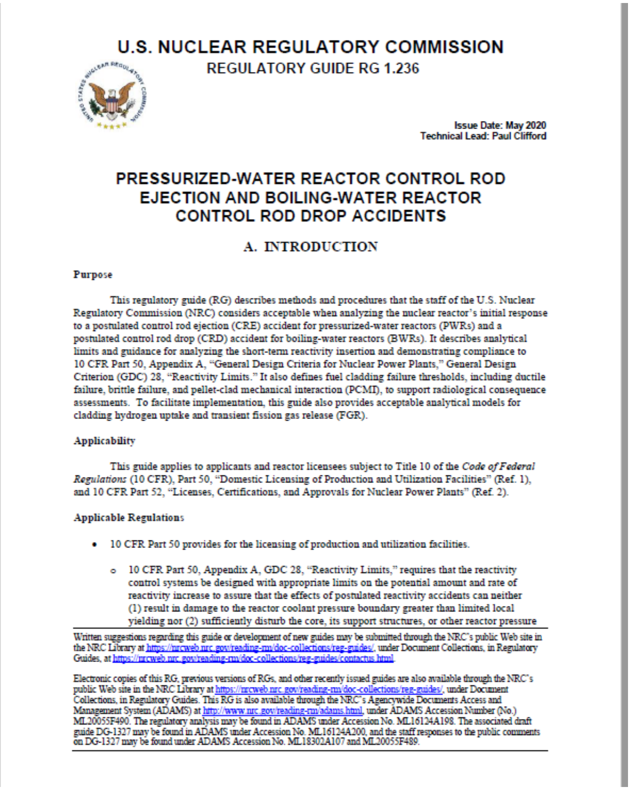
Regulatory Guide 1.236
PWR Control Rod Ejection and BWR Control Rod Drop Accidents

ACRS Full Committee
June 3, 2020

Paul M. Clifford
Division of Safety Systems
Nuclear Reactor Regulation

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Agenda



U.S. NUCLEAR REGULATORY COMMISSION
REGULATORY GUIDE RG 1.236

Issue Date: May 2020
Technical Lead: Paul Clifford

PRESSURIZED-WATER REACTOR CONTROL ROD EJECTION AND BOILING-WATER REACTOR CONTROL ROD DROP ACCIDENTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes methods and procedures that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable when analyzing the nuclear reactor's initial response to a postulated control rod ejection (CRE) accident for pressurized-water reactors (PWRs) and a postulated control rod drop (CRD) accident for boiling-water reactors (BWRs). It describes analytical limits and guidance for analyzing the short-term reactivity insertion and demonstrating compliance to 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 28, "Reactivity Limits." It also defines fuel cladding failure thresholds, including ductile failure, brittle failure, and pellet-clad mechanical interaction (PCMI), to support radiological consequence assessments. To facilitate implementation, this guide also provides acceptable analytical models for cladding hydrogen uptake and transient fission gas release (FGR).

Applicability

This guide applies to applicants and reactor licensees subject to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 1), and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 2).

Applicable Regulations

- 10 CFR Part 50 provides for the licensing of production and utilization facilities.
  - 10 CFR Part 50, Appendix A, GDC 28, "Reactivity Limits," requires that the reactivity control systems be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor pressure

Written suggestions regarding this guide or development of new guides may be submitted through the NRC's public Web site in the NRC Library at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/, under Document Collections, in Regulatory Guides, at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/contactus.html.

Electronic copies of this RG, previous versions of RGs, and other recently issued guides are also available through the NRC's public Web site in the NRC Library at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/, under Document Collections, in Regulatory Guides. This RG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under ADAMS Accession Number (No.) ML20055F490. The regulatory analysis may be found in ADAMS under Accession No. ML16124A198. The associated draft guide DG-1327 may be found in ADAMS under Accession No. ML16124A200, and the staff responses to the public comments on DG-1327 may be found under ADAMS Accession No. ML18302A107 and ML20055F489.

1. Regulatory Requirements
2. Guidance Summary
3. Timeline and Stakeholder Comments
3. Guidance Updates
   a. Damaged Core Coolability
   b. Radiological Consequences
   c. Cladding Hydrogen Models
   d. BU Extension

Reason for Concern

- Fatal accident at Army's prototype modular reactor – Stationary Low Power Reactor (SL-1)
- Improper withdrawal of central control rod resulted in prompt critical power excursion and steam explosion

Protection Against Violent Explosion and Loss of Pressure Boundary

Idaho National Engineering and Environmental Laboratory, INEEL 81-3966

Regulatory Requirements

- 10 CFR 50, Appendix A GDC 28 requires reactivity control systems to be designed with appropriate **limits** on potential **amount** and **rate** of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor pressure vessel internals to impair significantly the capability to cool the core.
- 10 CFR 100.11 and 10 CFR 50.67 establish **radiation dose limits** for individuals at the boundary of the exclusion area and at the outer boundary of the low population zone.

RG 1.236 provides an acceptable means to meet requirements

Reactivity Insertion Accidents

- Reactivity insertion accidents are safety significant because of their potential ability to challenge fuel rod integrity, fuel bundle geometry, and the integrity of the reactor pressure boundary

- The uncontrolled movement of a single control rod out of the core results in a positive reactivity insertion that promptly increases local core power
  - Considered the limiting reactivity insertion accident

- Of the various postulated single failures of the CRD system which may initiate an uncontrolled movement of a single control rod, PWR CRE and BWR CRD are considered the most limiting scenarios for the current operating fleet

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Protecting People and the Environment

Guidance Summary

- Building upon latest research data, RG 1.236 represents a significant advancement in guidance
- Separately captures fabrication-, burnup-, and corrosion-effects on fuel rod performance under RIA conditions

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RG 1.236, Page 4

Timeline

1974 RG 1.77, Assumptions used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors

1980 *Nuclear Safety* article (MacDonald et.al.) suggests need for new analytical limits for coolable geometry and failure threshold

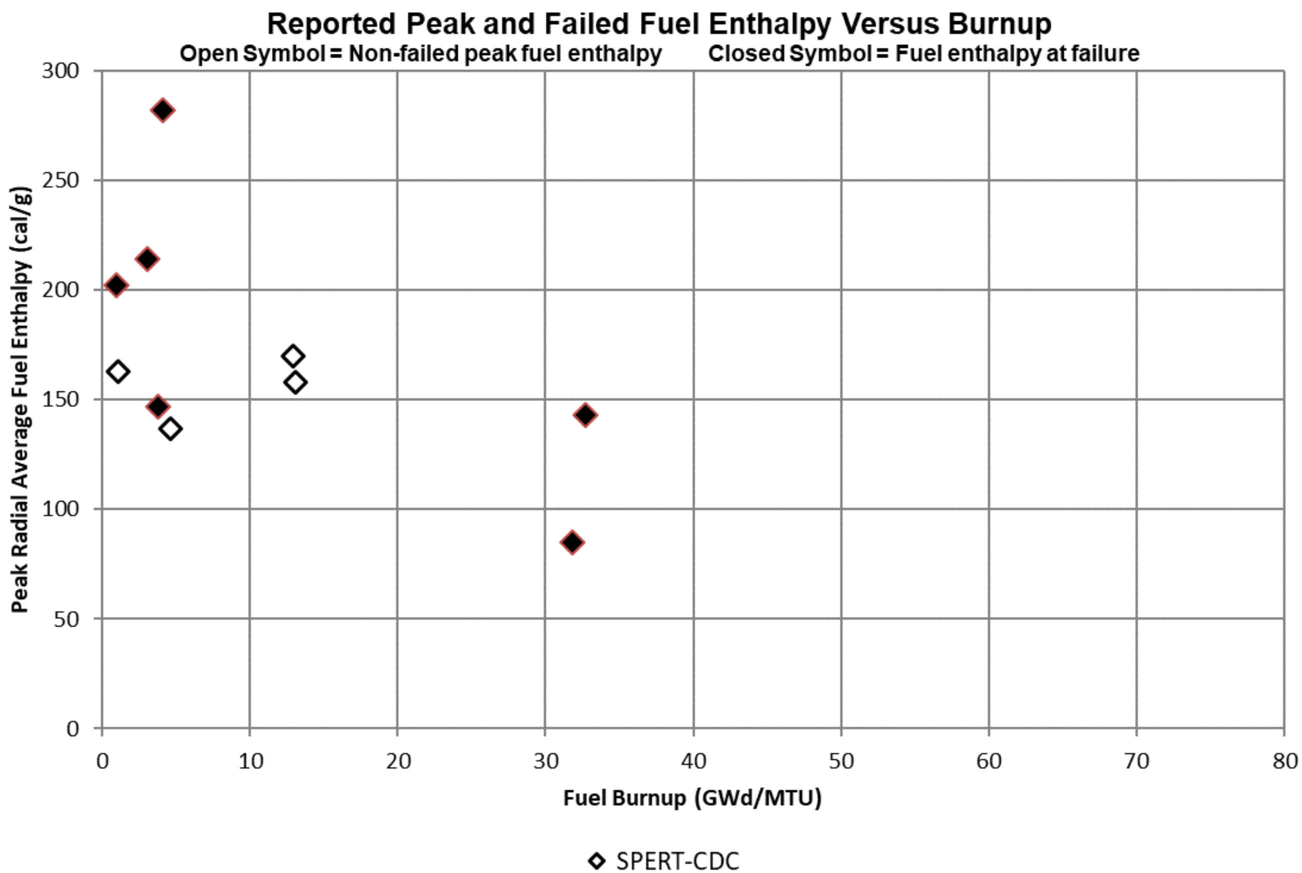
2004 RIL-0401, An Assessment of Postulated Reactivity-Initiated Accidents (RIAs) for Operating Reactors in the U.S.

2007 SRP 4.2, Appendix B, Interim Acceptance Criteria and Guidance for the Reactivity Initiated Accidents

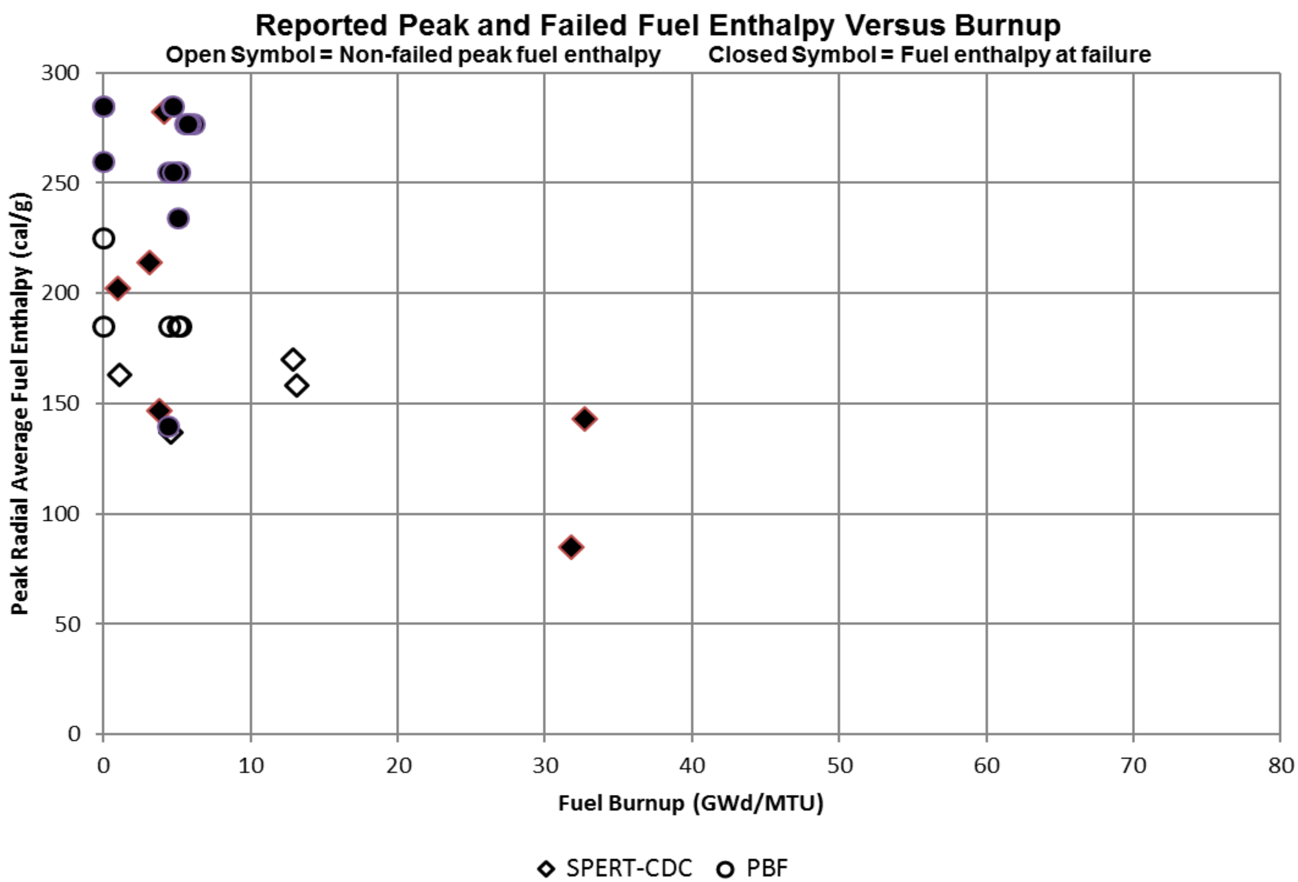
2017 DG-1327 1st public comment period

2019 DG-1327 2nd public comment period

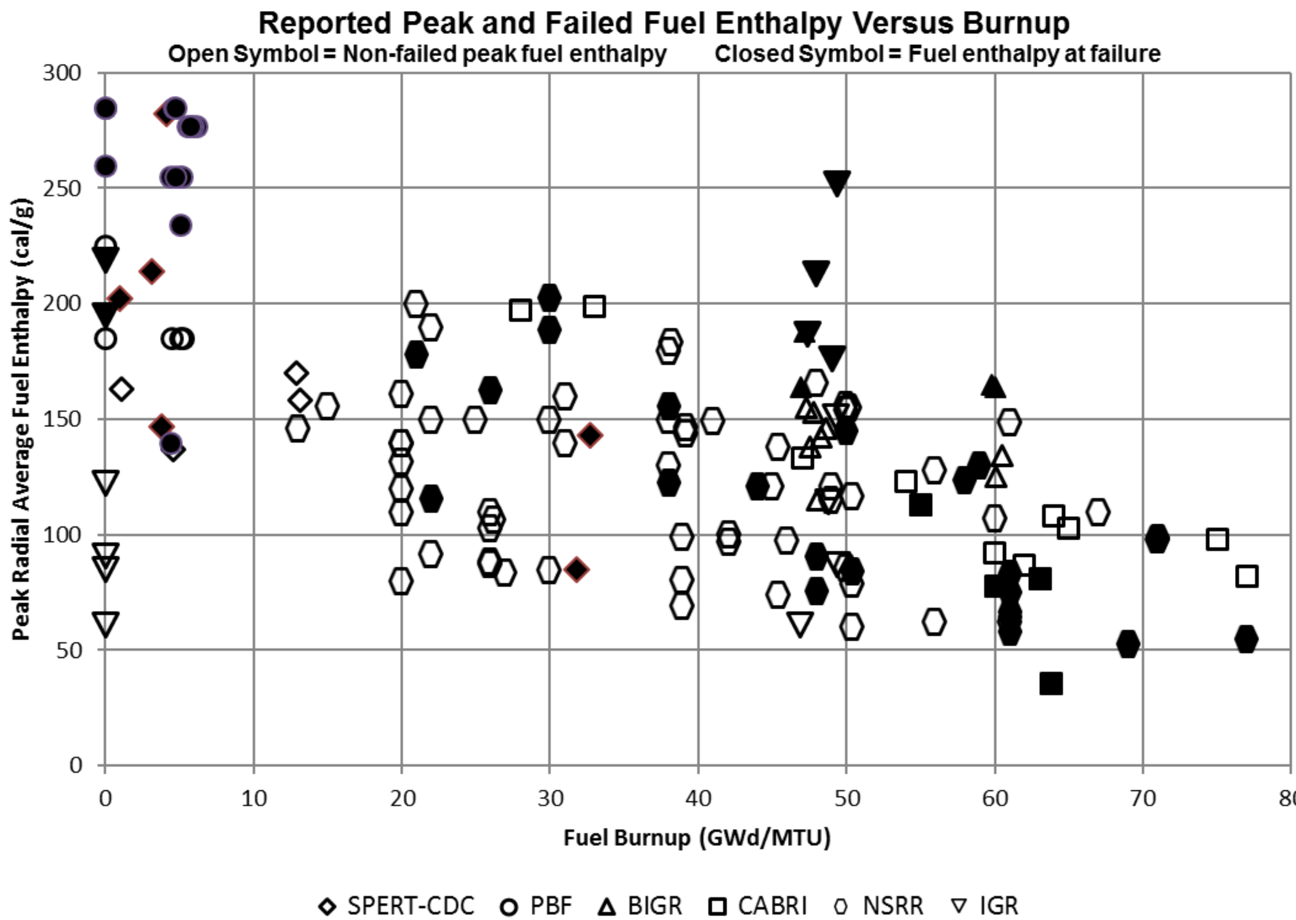
Timeline - 1974



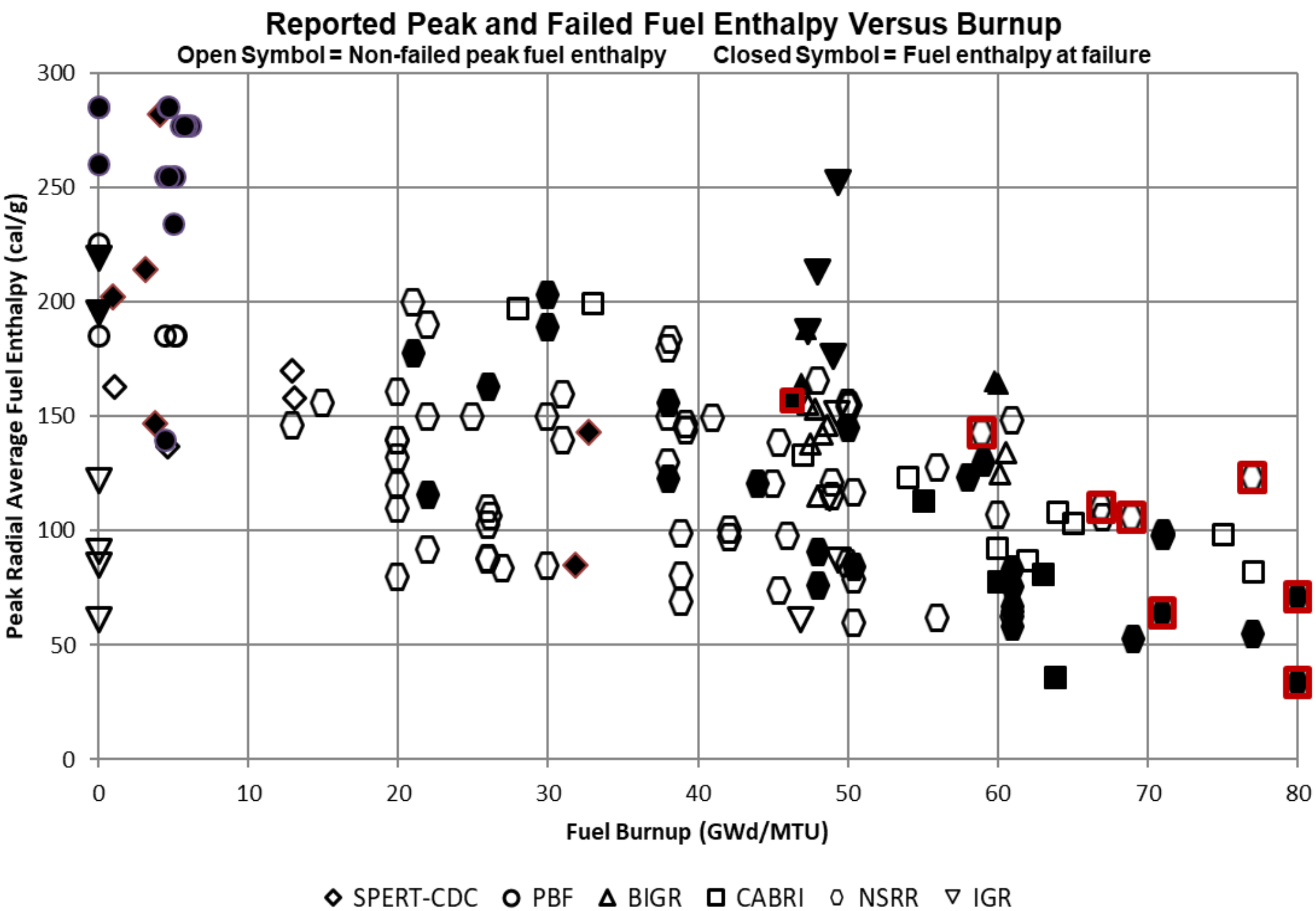
Timeline - 1980



Timeline - 2004

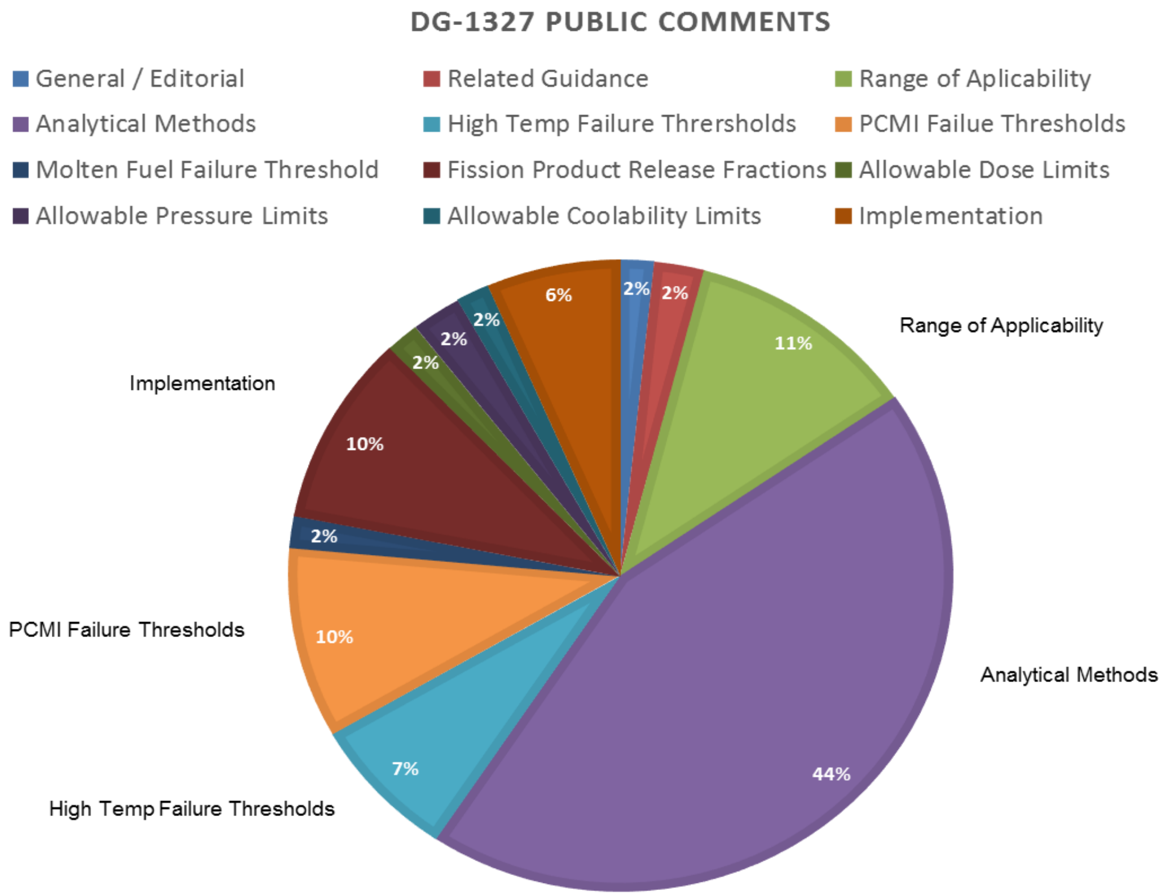


Timeline - 2020



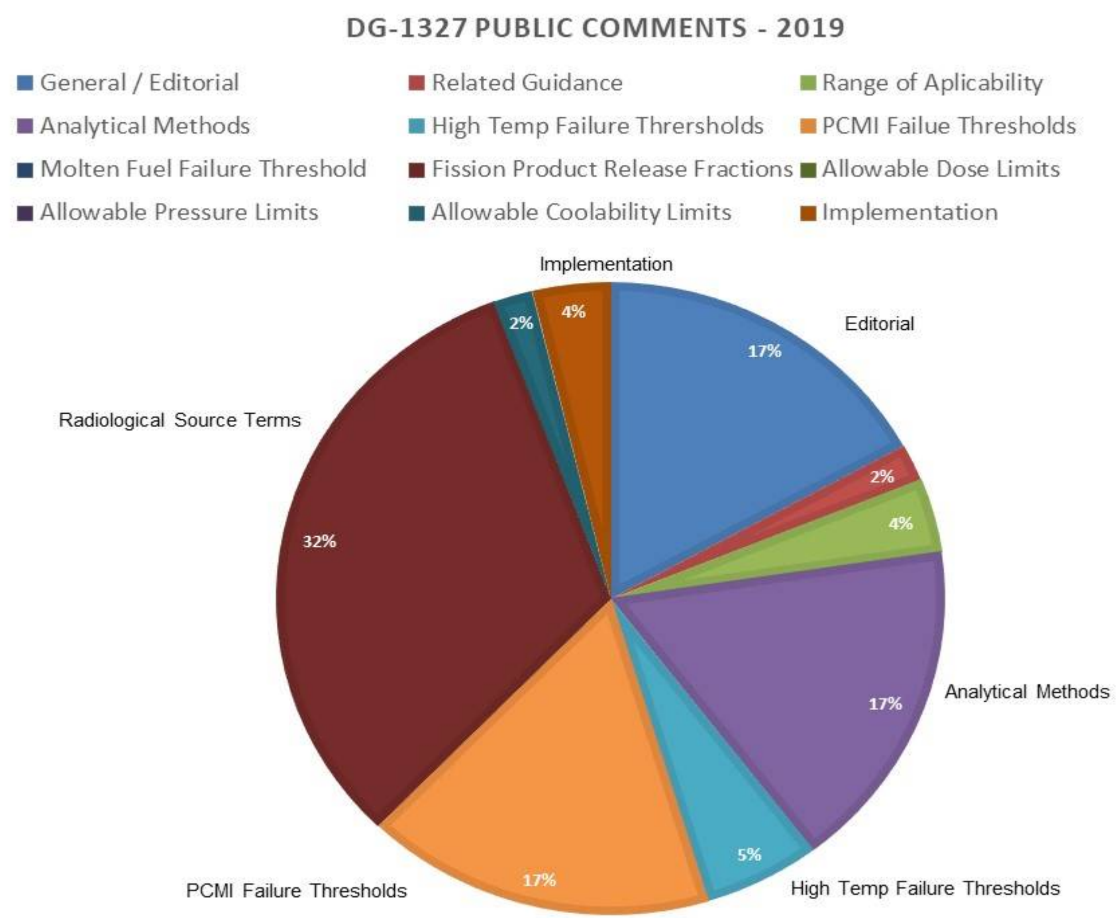
Public Comment - 2017

- **Comment submissions received from 12 stakeholders with a total 124 comments**
  - **Over 100 comments were accepted**



Public Comment - 2019

- **Comment submissions received from 7 stakeholders with a total 54 comments**
  - **Over 30 comments were accepted**



Major Changes

- Expanded fuel burnup range to 68 GWd/MTU (Section C.1)
- Improved analytical requirements (Section C.2)
- Revised PCMI cladding failure threshold curves (Section C.3)
- Removed radiological source term information (Section C.4)
  - Analytical requirements
  - Fission product gap release fractions → Future revision to RG 1.183
  - Analytical procedure
- Amended implementation to reflect revised Backfit guidance (Section D)
- Added cladding hydrogen uptake models (Appendix C)

Agenda

U.S. NUCLEAR REGULATORY COMMISSION
REGULATORY GUIDE RG 1.236

Issue Date: May 2020
Technical Lead: Paul Clifford

PRESSURIZED-WATER REACTOR CONTROL ROD EJECTION AND BOILING-WATER REACTOR CONTROL ROD DROP ACCIDENTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes methods and procedures that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable when analyzing the nuclear reactor's initial response to a postulated control rod ejection (CRE) accident for pressurized-water reactors (PWRs) and a postulated control rod drop (CRD) accident for boiling-water reactors (BWRs). It describes analytical limits and guidance for analyzing the short-term reactivity insertion and demonstrating compliance to 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 28, "Reactivity Limits." It also defines fuel cladding failure thresholds, including ductile failure, brittle failure, and pellet-clad mechanical interaction (PCMI), to support radiological consequence assessments. To facilitate implementation, this guide also provides acceptable analytical models for cladding hydrogen uptake and transient fission gas release (FGR).

Applicability

This guide applies to applicants and reactor licensees subject to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 1), and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 2).

Applicable Regulations

- 10 CFR Part 50 provides for the licensing of production and utilization facilities.
  - 10 CFR Part 50, Appendix A, GDC 28, "Reactivity Limits," requires that the reactivity control systems be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor pressure

Written suggestions regarding this guide or development of new guides may be submitted through the NRC's public Web site in the NRC Library at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/, under Document Collections, in Regulatory Guides, at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/contactus.html.

Electronic copies of this RG, previous versions of RGs, and other recently issued guides are also available through the NRC's public Web site in the NRC Library at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/, under Document Collections, in Regulatory Guides. This RG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under ADAMS Accession Number (No.) ML20055F490. The regulatory analysis may be found in ADAMS under Accession No. ML16124A198. The associated draft guide DG-1327 may be found in ADAMS under Accession No. ML16124A200, and the staff responses to the public comments on DG-1327 may be found under ADAMS Accession No. ML18302A107 and ML20055F489.

1. Regulatory Requirements
2. Guidance Summary
3. Timeline and Stakeholder Comments
3. Guidance Updates
   a. Damaged Core Coolability
   b. Radiological Consequences
   c. Cladding Hydrogen Models
   d. BU Extension

Protect Against Loss of Fuel Bundle Geometry

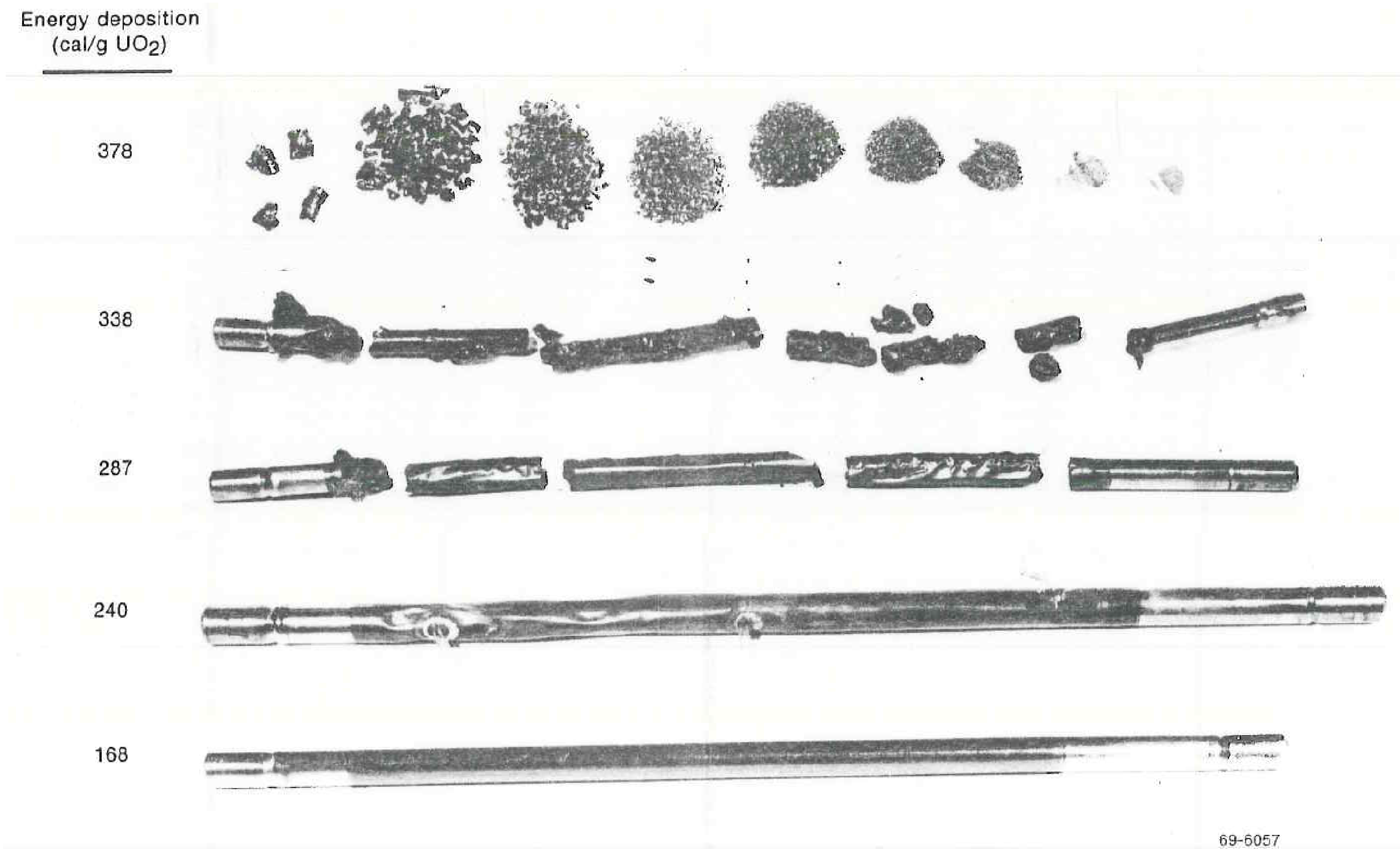


Fig. 3 Posttest photographs of SPXM rods tested in the CDC.

Coolability Analytical Limits

6. Allowable Limits on Damaged Core Coolability

Limiting peak radial average fuel enthalpy to prevent catastrophic fuel rod failure and avoiding molten fuel-coolant interaction is an acceptable metric to demonstrate that there is limited damage to core geometry and that the core remains amenable to cooling. The following restrictions should be met:

a. Peak radial average fuel enthalpy should remain below 230 cal/g.

b. A limited amount of fuel melting is acceptable provided that it is less than 10 percent of fuel volume. If fuel melting occurs, the peak fuel temperature in the outer 90 percent of the fuel volume should remain below incipient fuel melting conditions.

- Loss of fuel rod geometry limit (230 cal/g) based on earlier SPERT, PBF and NSRR prompt critical experiments
- Limited centerline melt (current license bases) avoids molten FCI
- Fuel melt becomes more limiting at ~30 GWd/MTU
- Preserves coolable geometry - satisfies GDC-28

Radiological Consequences

1. Requires a conservative estimate of the total number of failed fuel pins from all failure modes
   - Prompt critical high temperature cladding failure
   - Non-prompt DNB/CPR cladding failure
   - PCMI cladding failure
   - Centerline fuel melt cladding failure

2. Requires a conservative estimate of fission product release fractions
   - Steady-state gap inventories
   - Transient fission gas release → Future revision to RG 1.183
   - Fuel melt fission gas release

HT Cladding Failure Threshold

3.1 High-Temperature Cladding Failure Threshold

Figure 1 shows the empirically based high-temperature cladding failure threshold. This composite failure threshold encompasses both brittle and ductile failure modes and should be applied for events with prompt critical excursions (i.e. ejected rod worth or drop rod worth greater than or equal to $1.0). Because ductile failure depends on cladding temperature and differential pressure (i.e., rod internal pressure minus reactor pressure), the composite failure threshold is expressed in peak radial average fuel enthalpy (calories per gram (cal/g)) versus fuel cladding differential pressure (megapascals (MPa)).

For prompt critical scenarios which experience a prolonged power level following the prompt pulse, fuel cladding failure is presumed if local heat flux exceeds thermal design limits (e.g., departure from nucleate boiling and critical power ratios).

For non-prompt critical excursions, fuel cladding failure is presumed if local heat flux exceeds thermal design limits.

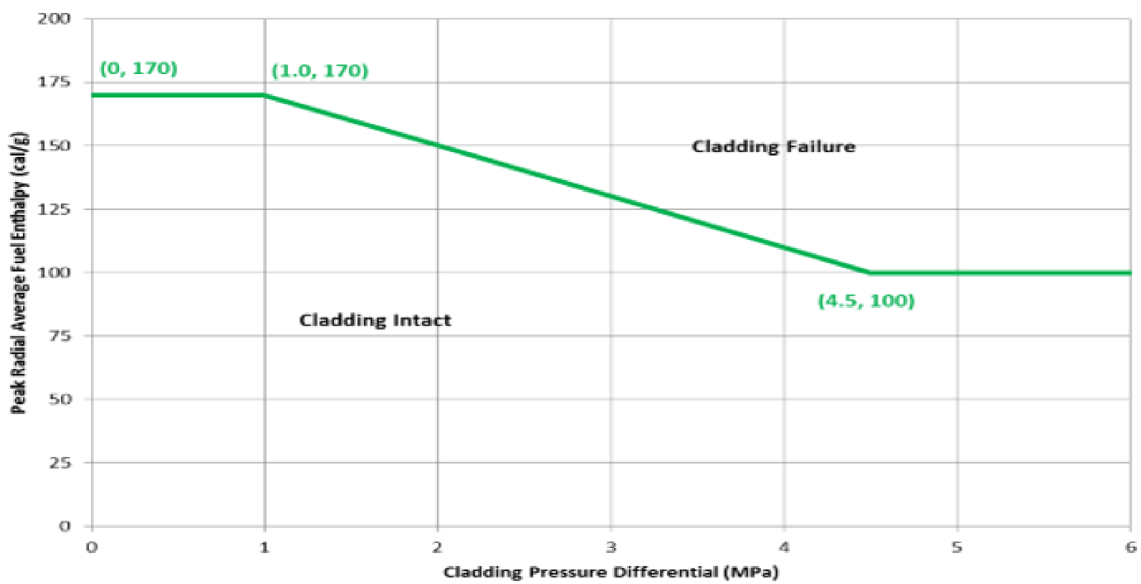
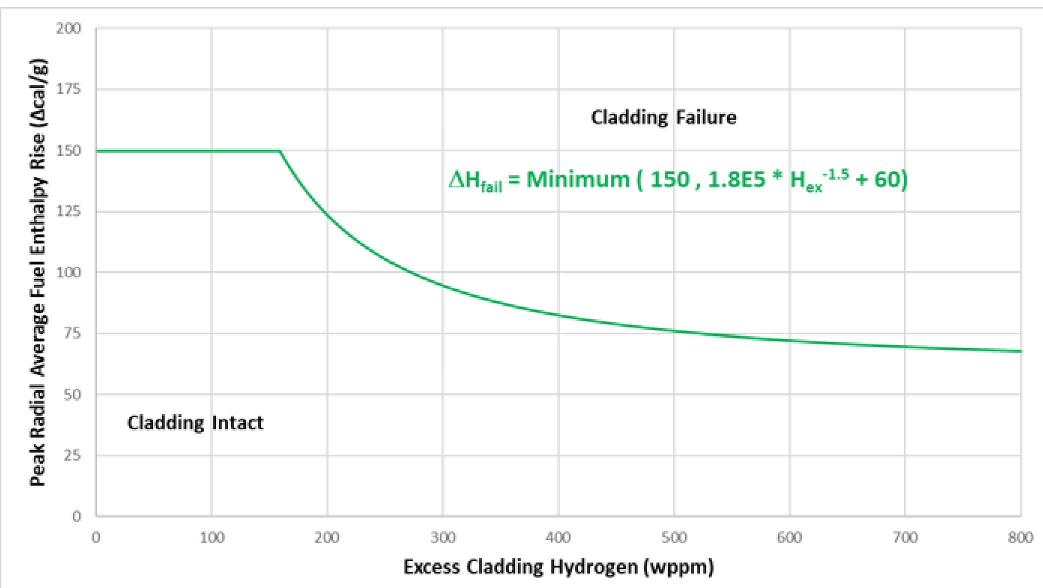


Figure 1. High-Temperature Cladding Failure Threshold

PCMI Cladding Failure

3.2 PCMI Cladding Failure Threshold

Figures 2 through 5 show the empirically based PCMI cladding failure thresholds. Because fuel cladding ductility is sensitive to hydrogen content, zirconium hydride orientation, and initial temperature, separate PCMI failure curves are provided for RXA and SRA cladding types at both low initial cladding temperature conditions (i.e., below 500 degrees F down to BWR cold startup) and high initial cladding temperature conditions (i.e., at or above 500 degrees F). The RXA cladding failure threshold is further refined for cladding designs with and without a barrier liner (e.g., sponge or low allow cladding inside diameter liner). The SRA cladding failure threshold is applicable regardless of the presence of a barrier liner. The PCMI cladding failure threshold is expressed in peak radial average fuel enthalpy rise (Δcal/g) versus excess cladding hydrogen content (wppm). Excess cladding hydrogen content refers to the portion of total hydrogen content in the form of zirconium hydrides (i.e., it does not include hydrogen in solution).



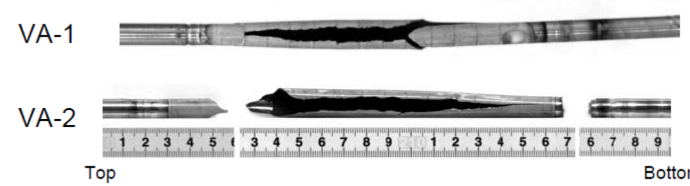
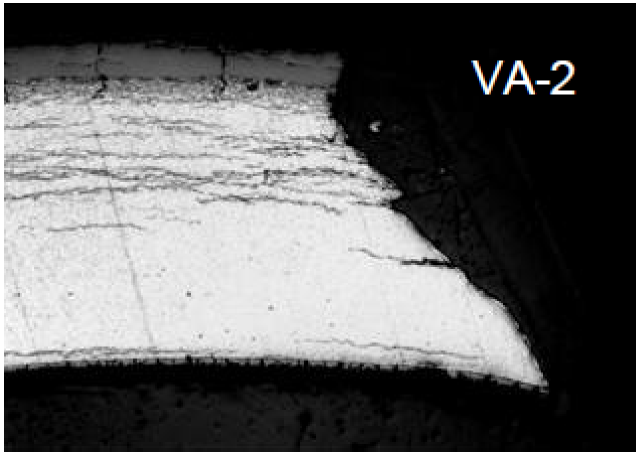


Figure 3. PCMI Cladding Failure Threshold—SRA Cladding at or above 500 Degrees F

Hydride Orientation

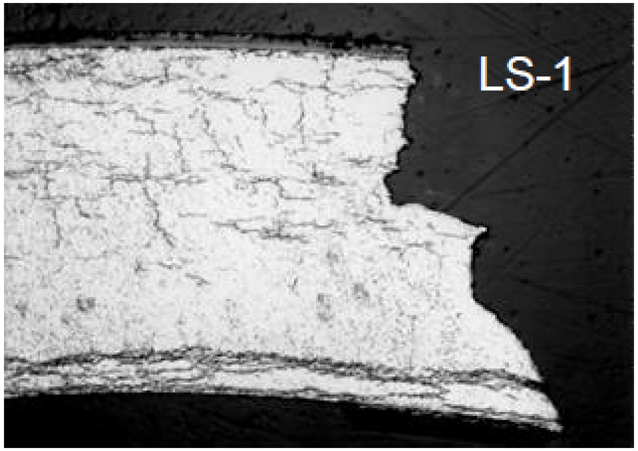
- Besides overall concentration, PCMI sensitive to hydride distribution and orientation which are influenced by:
  - Thermal and mechanical treatment during manufacturing
  - Stress state prevailing during hydride precipitation

PWR cladding
(stress-relieve annealed)



Burnup: 79 GWd/t
H content: 760 ppm
Failure at 55 cal/g

BWR cladding
(recrystallization annealed)



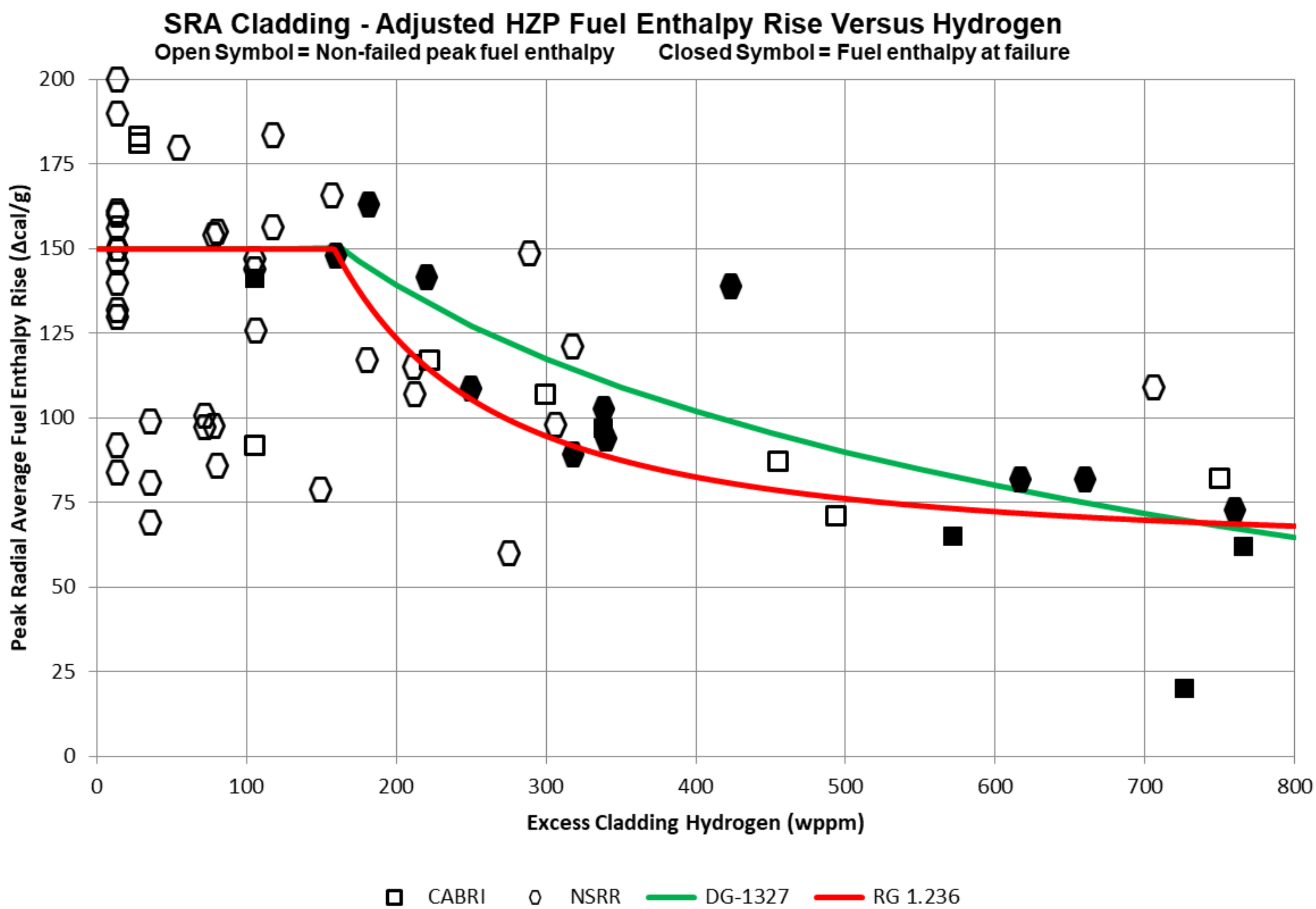
Burnup: 69 GWd/t
H content: ~300 ppm
Failure at 60 cal/g

T. Sugiyama, JAEA, "PCMI failure of high burnup fuels under RAI conditions," Fuel Safety Research Meeting, Tokai, Japan, May 2007

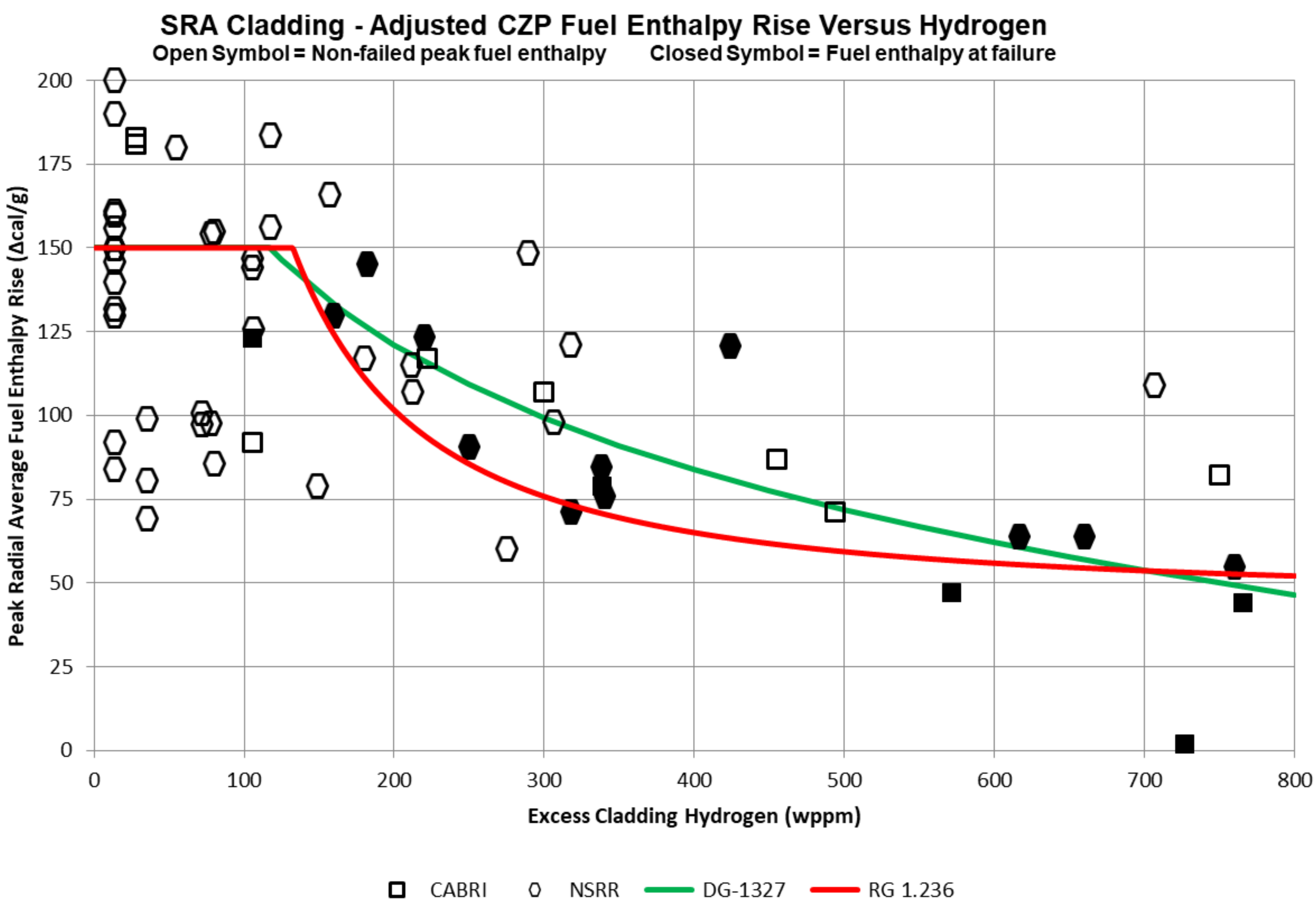
Separate PCMI Failure Thresholds

- Separate PCMI cladding failure threshold lines established which account for impacts associated with initial RCS temperature, excess hydrogen, and hydride sensitivity
  1. SRA cladding at high RCS coolant temperature
  2. SRA cladding at low RCS coolant temperature
  3. RXA cladding at high RCS coolant temperature
  4. RXA cladding at low RCS coolant temperature

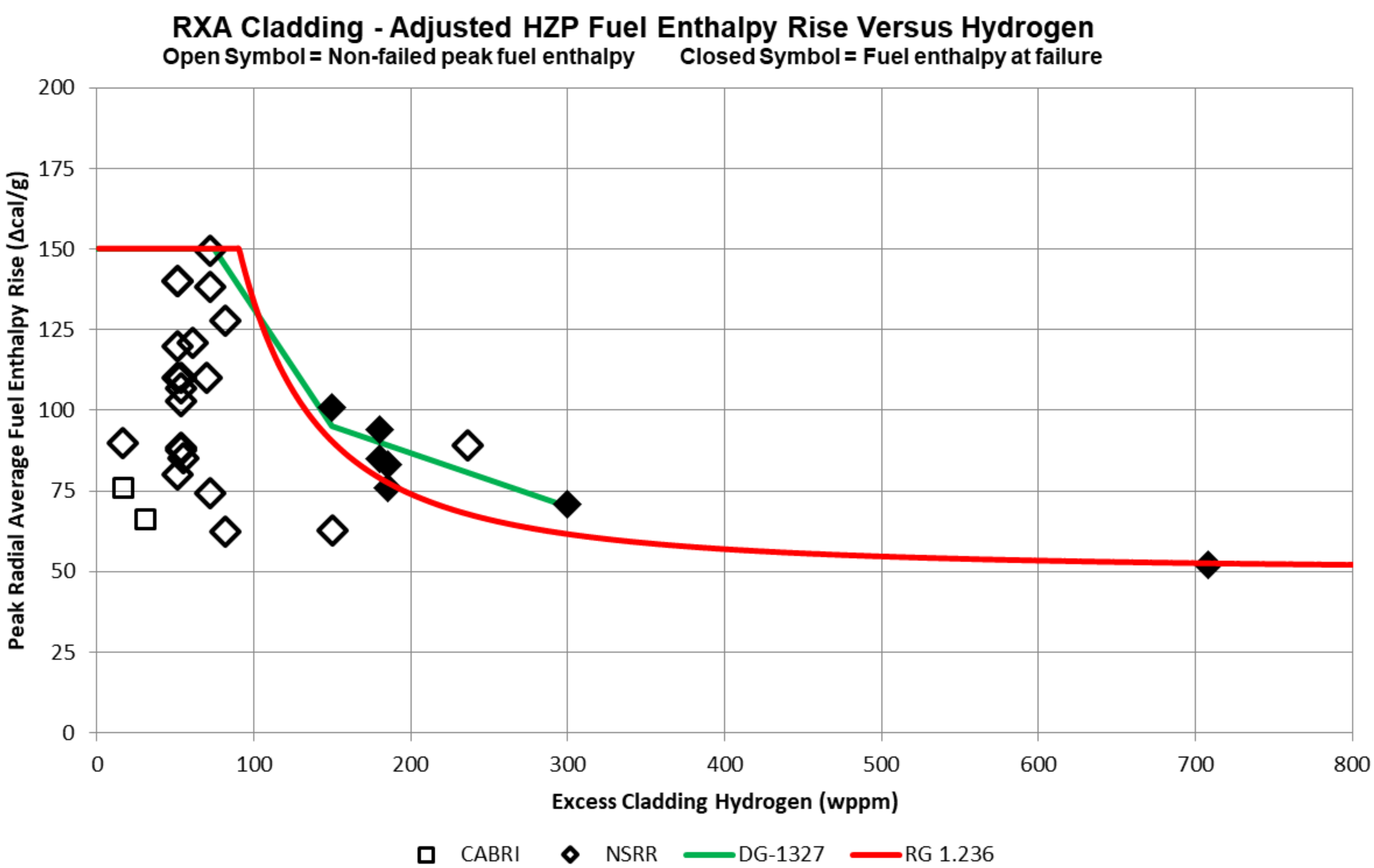
SRA Hot PCMI Failure Threshold



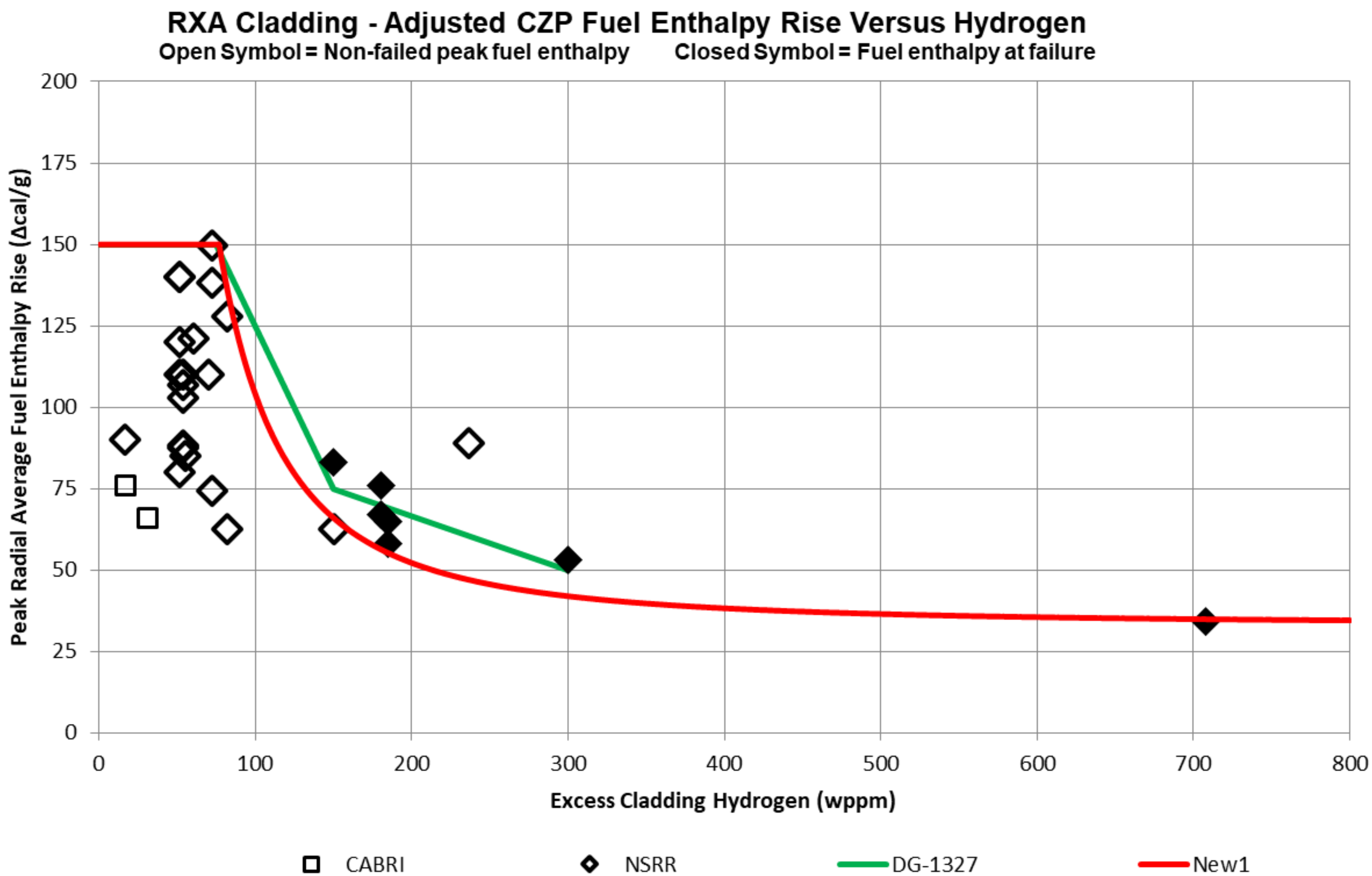
SRA Cold PCMI Failure Threshold



RXA Hot PCMI Failure Threshold

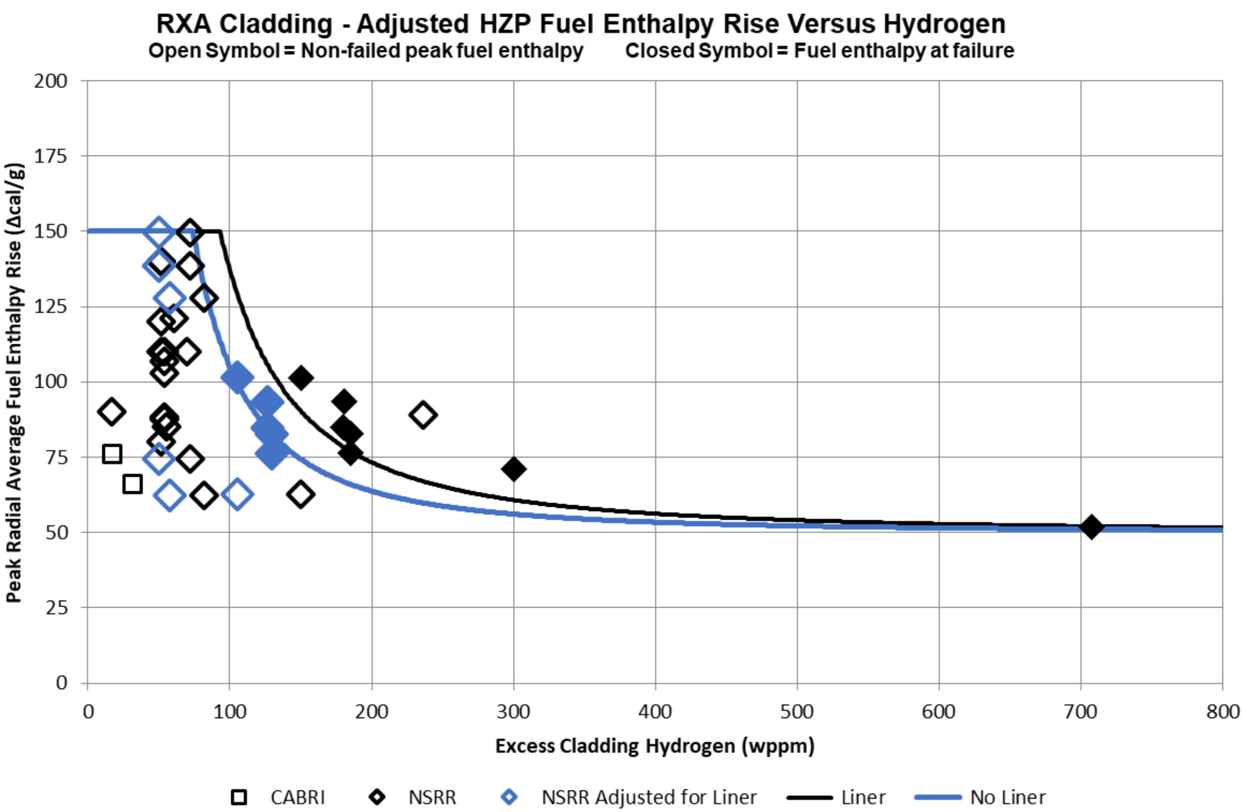


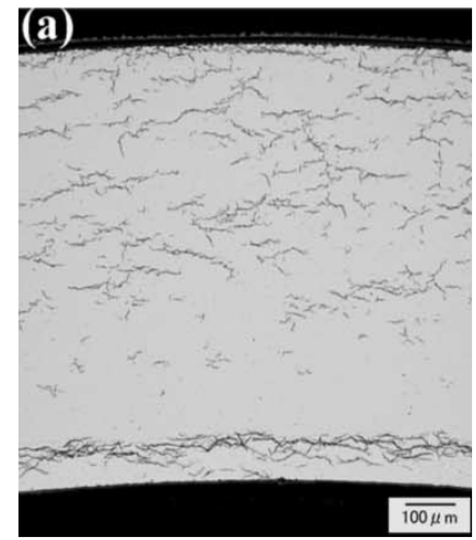
RXA Cold PCMI Failure Threshold



Impact of Barrier Liner

- In BWR liner (i.e., barrier) fuel, the natural or low alloy zirconium liner acts as a sponge for hydrogen.
  - Depletes base metal of detrimental effects of hydrides
  - Liner remains ductile even with high concentration of hydrides





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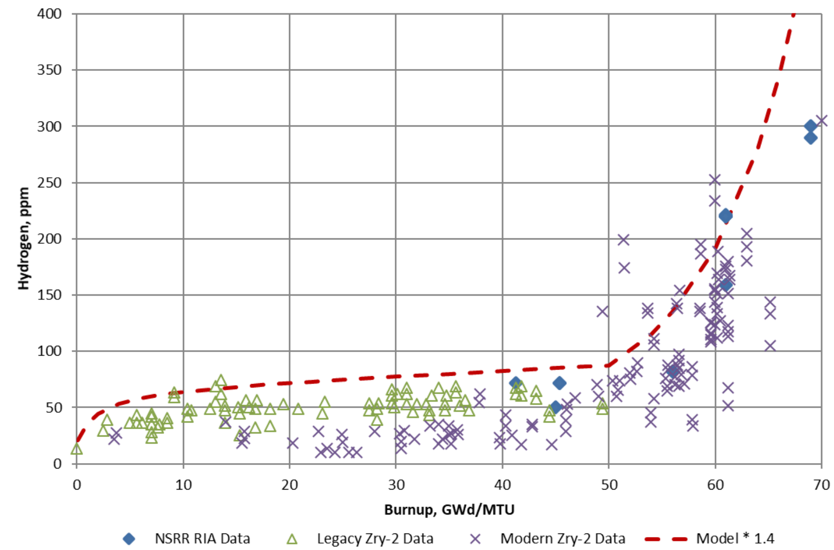
Protecting People and the Environment

Hydrogen Uptake Models

- Originally published in draft RG 1.224 (2015) in support of 50.46c rule
  - DG-1263 public comment period in 2014



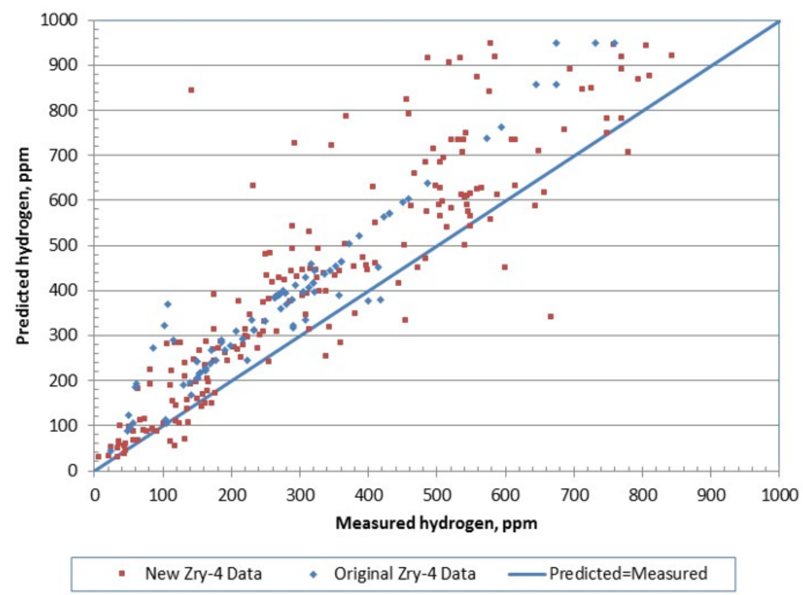
C-1. Zirconium Cladding Alloys in Pressurized-Water Reactors

Corrosion rates and the amount of corrosion at fuel discharge vary widely across the pressurized-water reactor (PWR) fleet because of alloy composition, operating conditions, and residence time (i.e., effective full-power days). Fuel vendors have approved fuel performance analytical tools along with corrosion models. In general, these corrosion models can predict a best estimate corrosion thickness as a function of effective full-power days and local operating conditions (fuel duty).

An examination of the empirical database of measured cladding hydrogen content for the current commercial zirconium alloys reveals that PWR cladding alloys do not exhibit the same breakaway hydrogen uptake at higher fluence levels as observed in Zircaloy-2 data for boiling-water reactors (BWRs). However, the pickup fraction does appear to be alloy specific. With consideration of the extent, uncertainty, and variability of the supporting database, the staff developed the following upper bound pickup fractions:

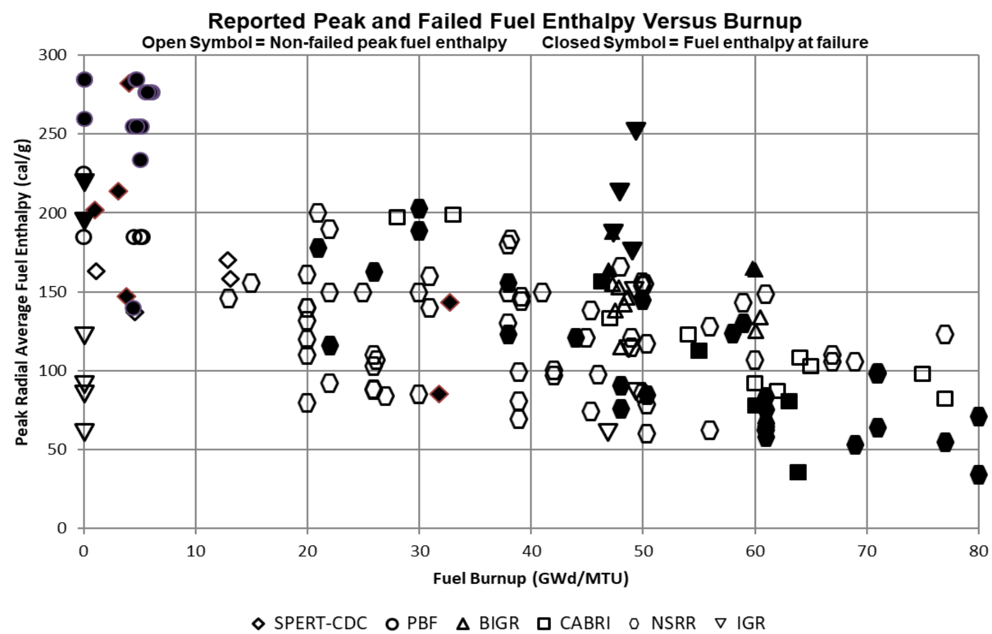
Zircaloy-4	20% hydrogen absorption
ZIRLO®	25% hydrogen absorption
Optimized ZIRLO™	25% hydrogen absorption
M5®	15% hydrogen absorption

These hydrogen pickup fractions should be used, along with a best estimate prediction of the peak oxide thickness using an approved fuel rod thermal-mechanical model, to estimate the cladding hydrogen content.



Burnup Extension

- In support of near-term licensing actions to extend allowable fuel rod average burnup to 68 GWd/MTU*, staff completed a critical assessment of the empirical database supporting RG 1.236 guidance (ML20090A308)
- For each portion of the guidance, the staff (1) investigated sensitivity with burnup and (2) assessed the extent of empirical database
- Based on this work the applicability of RG 1.236 was expanded up to 68 GWd/MTU



* Empirical database reports test segment (i.e., local) burnup. Rod average 68 GWd/MTU equivalent to approximately 75 GWd/MTU test segment burnup.

Conclusions

- Based upon latest research data, revised research data, new analysis, and international perspectives, the NRC staff has developed CRE/CRD guidance in RG 1.236
  - Represents a significant advancement in guidance
    - Separately captures fabrication-, burnup-, and corrosion-effects on fuel rod performance under RIA conditions
- ACRS and stakeholder involvement starting prior to 2007
  - Several ACRS briefings beginning prior to Interim Guidance
  - Numerous public workshops and 3 rounds of public comments

May 29, 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 Full Committee Presentation: NuScale Topic – Boron Redistribution and Associated Design and DCA Changes," PM-0620-70244, 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 Full Committee Meeting on June 3, 2020. The materials support NuScale's presentation of boron redistribution and associated design changes in the NuScale Design Certification Application.

The enclosure to this letter is the nonproprietary presentation entitled "ACRS Full Committee Presentation: NuScale Topic – Boron Redistribution and Associated Design and DCA Changes," PM-0620-70244, 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

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Enclosure: "ACRS Full Committee Presentation: NuScale Topic – Boron Redistribution and Associated Design and DCA," PM-0620-70244, Revision 0

Enclosure:

"ACRS Full Committee Presentation: NuScale Topic – Boron Redistribution and Associated Design and DCA Changes," PM-0620-70244, Revision 0

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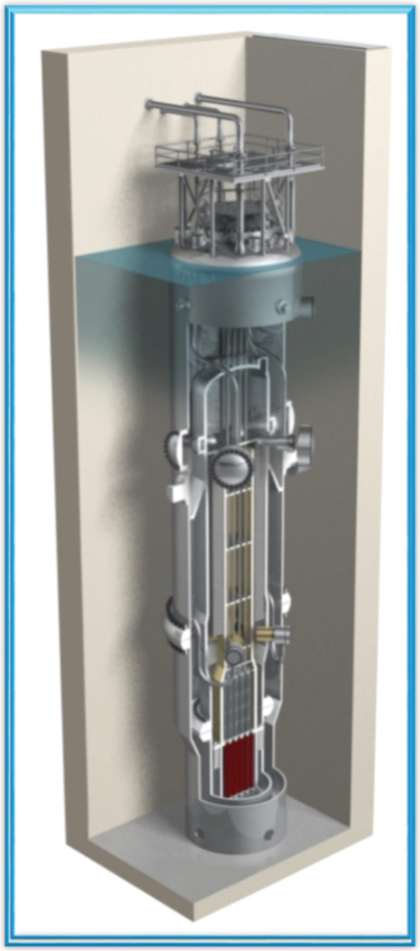
ACRS Full Committee Presentation



NuScale Topic

Boron Redistribution and Associated Design and DCA Changes

June 3, 2020

PM-0620-70244
Revision:0

Template #: 0000-21727-F01 R6

Presenters

Matthew Presson
Licensing Project Manager

Paul Infanger
Licensing Specialist

Ben Bristol
Supervisor, System Thermal-Hydraulics

Hannah Rooks
Supervisor, NSSS Systems Analysis

Sarah Bristol
Supervisor, Probabilistic Risk Assessment

Agenda

- Boron Redistribution Background
- Boron Dilution Analysis
- Event Scenarios
- Design Changes
- Safety Analysis
- Mechanical Analysis
- Probabilistic Risk Assessment
- DCA and Conforming Changes
- Conclusions

Boron Redistribution Background

- During ACRS subcommittee meetings in February 2020, scenarios were discussed that could lead to dilution of fluid in reactor pressure vessel (RPV) downcomer
- Under certain conditions, ECCS actuation or restoration of natural circulation flow could transport diluted coolant to the reactor core
- Postulated reactivity event could be outside those previously evaluated
  - Return to power (FSAR 15.0.6)
  - Boron dilution (FSAR 15.4.6)
  - Boron redistribution (RAI 8930)
- NuScale initiated an evaluation of the postulated scenarios in accordance with Corrective Action Program

Boron Dilution Analysis

Existing methods used bounding assumptions or assumed perfect mixing

- Large analysis conservatisms lead to unrealistic results
  - Large boron loss term for fluid in containment (CNV) below reactor recirculation valves (RRVs)
  - Boron lost in vapor through reactor vent valves (RVVs) due to volatility
  - No mechanism for boron recovery
- No methodology approved by the NRC exists for detailed boron mixing in downcomer or core
- Determined that the postulated boron redistribution scenarios could be eliminated through several minor design changes
- NRC initiated an audit (ML20059N687) to review the resolution of the postulated boron redistribution scenarios and associated changes to the NuScale Design Certification Application (DCA)
  - Daily interactions to support NRC staff review

Event Scenarios

- Potential events that required further evaluation for boron dilution
  - LOCAs
    - Condensation of water in CNV from RVVs
    - Condensation of unborated water in downcomer
    - ECCS actuation can transport unborated water to core
  - DHRS operation can shrink RCS inventory below top of riser
    - Condensation of unborated water in downcomer
    - Unborated water can enter core when restoring natural circulation or after ECCS actuation (24-hour timer on loss of AC power)
  - Anticipated Transient Without Scram (ATWS)
    - Condensation of unborated water in downcomer and CNV after RCS fluid lost through reactor safety valves (RSVs)
    - Unborated water can enter core when restoring natural circulation or opening ECCS valves

Design Changes

- Design Considerations
  - Ensure early actuation of ECCS for postulated LOCA events
    - Actuates ECCS while pressure and level in RPV are higher than CNV establishes flow out of RPV when ECCS valves open
    - After outflow, flow stagnates and slowly reverses through RRVs so that no large influx of unborated water can occur
  - Provide mechanism for boron mixing in the unlikely event that RCS level drops below riser
    - Eliminates potential dilution from restored natural circulation following analyzed DHRS cooldown scenarios or ATWS events
    - Eliminates potential dilution from operator action to restore natural circulation or manual ECCS actuation

Design Changes (continued)

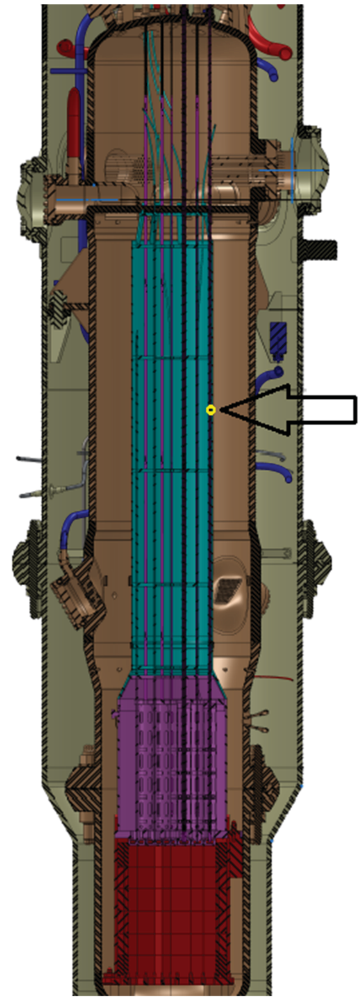
- Addition of ECCS actuation signal on low RCS pressure (less than 800 psia +/- 100 psi)
  - ECCS actuation prevented by either of following interlocks
    - CNV pressure less than 1 psia
    - RCS T_{hot} less than 475 ºF
- Interlocks prevent ECCS actuation for Non-LOCA events
  - RCS is subcooled in DHRS cooldown events (lower than 475 ºF) and have no increase in CNV pressure
  - Main steam line breaks and feedwater line breaks
    - RCS pressure remains above ECCS actuation pressure range during initial transient response
    - RCS is subcooled below 475 ºF T_{hot} interlock before RCS depressurizes to ECCS actuation range

Design Changes (continued)

- Lowered ECCS CNV level actuation setpoint
  - 252 inches (from 282 inches)
  - Level setpoint range remains above RRV
  - Actuates ECCS while RCS level and pressure greater than CNV level and pressure
  - Ensures initial flow out of RPV into CNV
  - Establishes boron mixing before ECCS flow into RPV

Design Changes (continued)

- Diverse flowpaths added to RPV riser
  - Provide a flow path from riser through the downcom
    to ensure boron mixing even if level drops below top
  - Four ¾ inch holes located at midpoint of SG
  - Impact to normal operation is minimal
    - Flow through holes is small (2 kg/s) compared to minim
      (535 kg/s)
  - Holes located below RCS contracted level from exte
    cooldown
  - Holes are above equilibrium riser level after ECCS a
    impact on LOCA cooling)
  - Additional detail about this design change included
    closed presentation



Safety Analysis

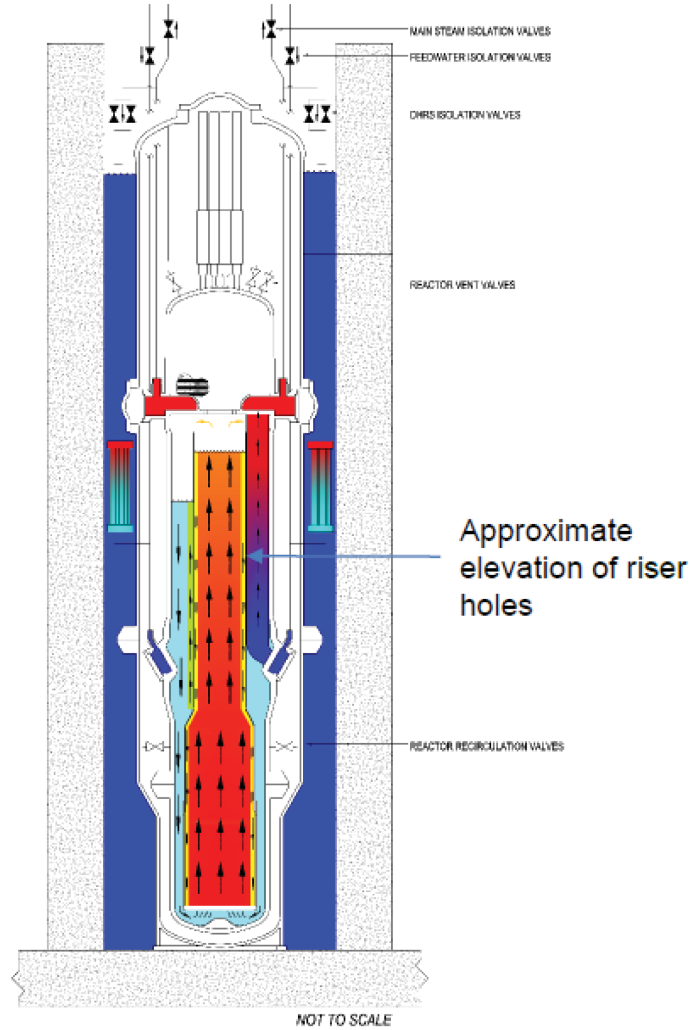
- Return to Power (FSAR 15.0.6)
  - End of cycle conditions remain limiting
  - No impact to the postulated limiting return to power scenario
  - Flow through riser holes maintains downcomer greater than critical boron concentration for events earlier in cycle
- Boron redistribution (RAI 8930)
  - Modifications maintain assumptions in redistribution analysis
- LOCA (FSAR 15.6.5)
  - Some postulated events would actuate ECCS on low RCS pressure (most steam space LOCAs and some liquid space LOCAs)
  - No change to limiting event MCHFR or collapsed liquid level
  - Minor changes to some non-limiting events

Safety Analysis (continued)

- Inadvertent RPV valve opening (FSAR 15.6.6)
  - No impact to limiting events (Loss of DC power events actuate ECCS on IAB threshold)
  - RVV opening events with power available, remaining ECCS valves open on RCS pressure or low valve ΔP
  - RRV events not affected (remaining valves open on CNV level)
  - RSV events remain bounded by inadvertent ECCS valve opening

Mechanical Analysis

- Mechanical design and analysis impacts of the riser holes
  - Negligible impact on full power RCS flow rate (approximately 0.1 kg/s)
  - Does not introduce structural integrity concerns due to flow-induced vibration
  - No update needed to CVAP Technical Report
  - Negligible impact to DHRS cooldowns



Mechanical Analysis (Continued)

- Flow Induced Vibration (FIV) Evaluation
  - The riser holes have been evaluated for FIV mechanisms
    - turbulent buffeting (TB)
      » Holes are small (volume reduction of upper riser approximately 1/26,000) – no impact to riser structural properties and TB evaluations not affected
    - vortex shedding (VS)
      » Riser holes not expected to generate vortices due to continuous flow through the holes
      » If vortices did form, would not be coincident with riser acoustic modes
    - Reviewed Operating Experience for fuel pin vibration due to baffle gap cross-flow
      » Normal flow through holes produces minimal force and no resonance with nearby components

Probabilistic Risk Assessment

- PRA Evaluation
  - Thermal hydraulic evaluation
  - PRA models
  - Risk significance and results

Beyond Design Basis Thermal Hydraulic Impacts

- Design changes incorporated into best estimate NRELAP5 PRA thermal hydraulics model
  - riser holes credited for preventing significant boron redistribution (per Chapter 15 analyses)
  - new ECCS actuation logic modeled
- Impact to postulated event progression
  - cycling RSV sequences now reach the new low RCS pressure ECCS actuation
  - DHRS credit to reduce rate of coolant loss of unisolated injection line pipe breaks outside containment mitigated with core flood and drain system (CFDS)
  - no impact to remaining sequences or assessments

PRA Model Impacts

- Negligible effect on ECCS fault tree model
  - fault tree does not credit all sensors/signals
- Negligible effect on ECCS initiating events
  - requires three sensors to spuriously actuate
- Success criteria
  - RSV cycling
  - DHRS credited to mitigate unisolated injection line pipe break
- Negligible effect on operator actions
  - modeled cues are unchanged

PRA Results

- Internal events
  - negligible change in the core damage frequency (CDF) and large release frequency (LRF)
  - negligible change in the conditional containment failure probability (CCFP)
  - no change in candidate risk-significant structures, systems, or components (SSCs)
  - no change in candidate risk-significant initiating events or human actions
  - no change in the significant core damage cutsets (FSAR Table 19.1-18)
  - no change in the significant large release cutsets (FSAR Table 19.1-26)
- External events
  - negligible effect
- Low power and shutdown
  - negligible effect
  - CVCS remains available during the plant cooldown to respond to RCS volume changes, as well as maintain adequate shutdown margin
  - holes in the riser will maintain RCS recirculation independent of operator action

PRA Summary

- Implementing the design changes to ECCS actuation, and the addition of riser bypass flow holes have a negligible effect on PRA results and insights
  – some PRA sequences that involve cycling the RSV will now result in ECCS actuation
  – riser holes credited to prevent significant boron redistribution
- Event tree logic has been updated to reflect the new event progressions for affected sequences.

DCA and Conforming Changes

- DCA Revision 4, Errata 2, submitted May 20, 2020
- Tier 1 Chapter 2
  - add new ECCS signal on low RCS Pressure
- FSAR Chapters
  - riser holes and structural evaluations (Sections 3.9, 5.4)
  - new ECCS actuation, interlocks and setpoint changes, passive ECCS valve opening, RCS wide range pressure instrumentation (Sections 3.2. 6.2, 6.3, 7.1, 7.2, 15.0, 15.6, 17.4)
  - downcomer boron dilution mechanism (Sections 4.3, 15.0)
  - LOCA analysis changes, sequence of events (Section 15.6.5)
  - PRA event sequences for new ECCS actuation and riser holes (Section 19.1)
- Technical Specifications and Bases
  - LCOs 3.3 Instrumentation and 3.5 ECCS

DCA and Conforming Changes (continued)

- *Technical Reports (submitted May 20, 2020)*
  - Instrument Setpoint Methodology (TR-0616-49121) – added ECCS Setpoint and Actuation range design changes
  - NSSS Advanced Sensor (TR-0316-22048) – added ECCS Setpoint and Actuation range design changes
  - Containment Response (TR-0516-49084) – added ECCS Setpoint and Actuation range design changes
  - Long-Term Cooling Methodology (TR-0916-51299) – added ECCS Setpoint and Actuation range design changes
  - Technical Specification Regulatory Conformance and Development (TR-1116-52011) – incorporated associated changes in instrumentation and bases
- GDC 33 Exemption – Possible revision to exemption basis being discussed with NRC staff. Not included in DCA Revision 4, Errata 2.

DCA Conforming Changes

- Topical Reports (submitted May 27, 2020)
  - LOCA Methodology (TR-0516-49422) – added ECCS Setpoint and Actuation range design changes. Added the Riser Hole design change.
    - No change to limiting cases for MCHFR and collapsed liquid level above TAF
    - Non-limiting cases remain non-limiting
  - Non-LOCA Methodology (TR-0516-49416) – added ECCS Setpoint and Actuation range and the Riser Hole design changes
    - Results for RCS pressure, core inlet temperature, RCS flow, and steam generator pressure confirmed to have negligible differences under DHRS cooling

Summary and Conclusions

- Design changes preclude boron redistribution for postulated design basis and beyond design basis events
  - ECCS actuation on low RCS pressure or high CNV level
    - Assures initial flow out of RPV to preclude influx of unborated water from CNV or downcomer
  - Riser holes assure boron mixing in downcomer and core
    - when DHRS cools and shrinks RCS level below the riser
    - smaller LOCAs/RCS leaks while RCS level is above holes
- Analyses demonstrate no significant changes to results and that acceptance criteria continue to be met
- The evaluation and resolution of this topic involved the evaluation of a broad scope of postulated scenarios, extensive calculations, analyses and related document changes to develop and implement the design changes

Acronyms

AC – alternating current
ACRS – Advisory Committee on Reactor Safeguards
AOO – Anticipated Operational Occurrences
ATWS – anticipated transient without scram
CCFP – conditional containment failure probability
CDF - core damage frequency
CFDS – core flood and drain system
CHF – Critical Heat Flux
CNV – containment vessel
COL – Combined License
CVAP – Comprehensive Vibration Assessment Program
CVCS – chemical and volume control system
DCA - Design Certification Application
DHRS – decay heat removal system
ECCS – emergency core cooling system
EOC – end of cycle
ºF – degree Fahrenheit scale
FIV – flow induced vibration
FSAR - Final Safety Analysis Report
GDC – General Design Criteria
IAB – inadvertent actuation block
kg - kilogram
LCO – Limiting Condition for Operation
LOCA – loss-of-coolant accident
LRF – large release frequency
MCHFR – minimum critical heat flux ratio
NPM – NuScale Power Module
ΔP – differential pressure
Psia – pounds per square inch absolute
RAI – Request for Additional Information
RCS – reactor coolant system
RPV – reactor pressure vessel
RRV – reactor recirculation valve
RSV – reactor safety valve
RTP – return to power
RVV – reactor vent valve
/s – per second
SAFDL – specified acceptable fuel design limits
SDM – shutdown margin
SG – steam generator
TB – turbulent buffering
TAF – top of active fuel
VS – vortex shedding

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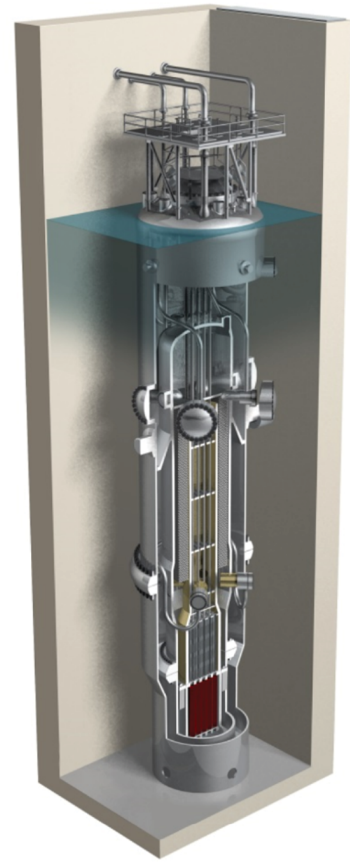

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Chapter 15, “Transient and Accident Analyses"

Open Item Update: Audit of Boron Redistribution/Applicable Design Changes

NuScale Design Certification Application

ACRS Full Committee Meeting
June 3, 2020

Non-Proprietary

Agenda

- April 29, 2020, ACRS FC Letter
- Background
- Design Changes
- Impacted Chapter SERs
- Next Step

ACRS FC Letter

The April 29, 2020, ACRS FC letter contained the following two conclusions and recommendations:

1. We concur with the staff's conclusions in Chapter 15 of their Advanced SE Report: all open items, including those unresolved from the earlier SE, have been resolved. However, a new issue related to boron redistribution remains open.

2. Major conclusions from our focus areas are the following:

    - Return to Criticality – The low risk of event sequences associated with return to criticality makes the General Design Criterion (GDC) 27 exemption acceptable.
    - Boron Redistribution – The issue remains open. The Applicant and the staff are working on its resolution. We will review the final staff evaluation.

Background

- February 27, 2020, NuScale notified NRC staff of an error in their boron redistribution analysis and informed that they are following their corrective action program. On March 2, 2020, staff issued an audit plan in anticipation of NuScale generating corrected calculations. Staff held an audit entrance on March 4, 2020, and since then, has held multiple public meetings to discuss relevant design change issues.

- On May 1, 2020, staff sent a schedule letter (ML20112F455) to NuScale. The purpose of this letter was to communicate the status of the NRC staff's review of the NuScale design certification application given the current schedule and the need for additional design changes.

- On May 20, 2020, NuScale submitted, "Second Updates to DCA Rev 4," that includes final design change documents for NRC review (ML20141L787).

Design Changes

NuScale Design Changes Under Review (w/Impacted DCA Chapters):

- High containment level change (I&C-Chapter 7, Reactor Systems-Chapter 15, Containment-Chapter 6)
    - ECCS actuation range is adjusted down to mitigate the accumulation of condensate in containment prior to an actuation signal. The new analytical limit ranges from 240”-264” (previously 264”-300”).
- New ECCS actuation signal (I&C-Chapter 7, Reactor Systems-Chapter 15, Containment-Chapter 6, PRA-Chapter 19, TS-Chapter 16, Operations-Chapter 13)
    - A new actuation signal has been added to the design, based on a low Wide Range Reactor Coolant System Pressure signal of less than 800 psia. This signal allows for a faster ECCS response in small-break LOCA scenarios, and mitigates the accumulation of condensate in the downcomer.
    - Associated bypass signals include Thot < 475^{o}F, or containment pressure < 1 psia. Actuation based on a low Wide Range RCS signal will only occur when both Thot > 475^{o}F and containment pressure > 1 psia (i.e. LOCA conditions)
- Addition of riser holes (Reactor Systems-Chapter 15, Containment-Chapter 6, PRA-Chapter 19, TS-Chapter 16, Operations-Chapter 13, Mechanical-Chapter 3)
    - Several small flow paths were added to the upper riser, allowing a limited flow of reactor coolant into the steam generator tube region. This allows for sufficient boron concentrations to remain in the reactor coolant under postulated extended riser uncovery conditions.

Impacted Chapter SERs

- Chapter 3 - Design of Structures, Components, Equipment, and Systems
- Chapter 4 - Reactor
- Chapter 5 - Reactor Coolant System and Connecting Systems
- Chapter 6 - Engineered Safety Features
- Chapter 7 - Instrumentation and Controls
- Chapter 9 - Auxiliary Systems
- Chapter 13 - Conduct of Operations
- Chapter 15 - Transient and Accident Analyses
- Chapter 16 - Technical Specifications
- Chapter 19 - Probabilistic Risk Assessment and Severe Accident Evaluation

Impacted Topical & Technical Reports

Impact – 5 Technical Reports (<u>support various chapters/SERs </u>):

- TR-0616-49121, Setpoint Methodology
- TR-0316-22048, Advanced Sensor
- TR-0516-49084, Containment Response
- TR-0916-51299, Long Term Cooling
- TR-1116-52011, Technical Specifications Regulatory Conformance and Development

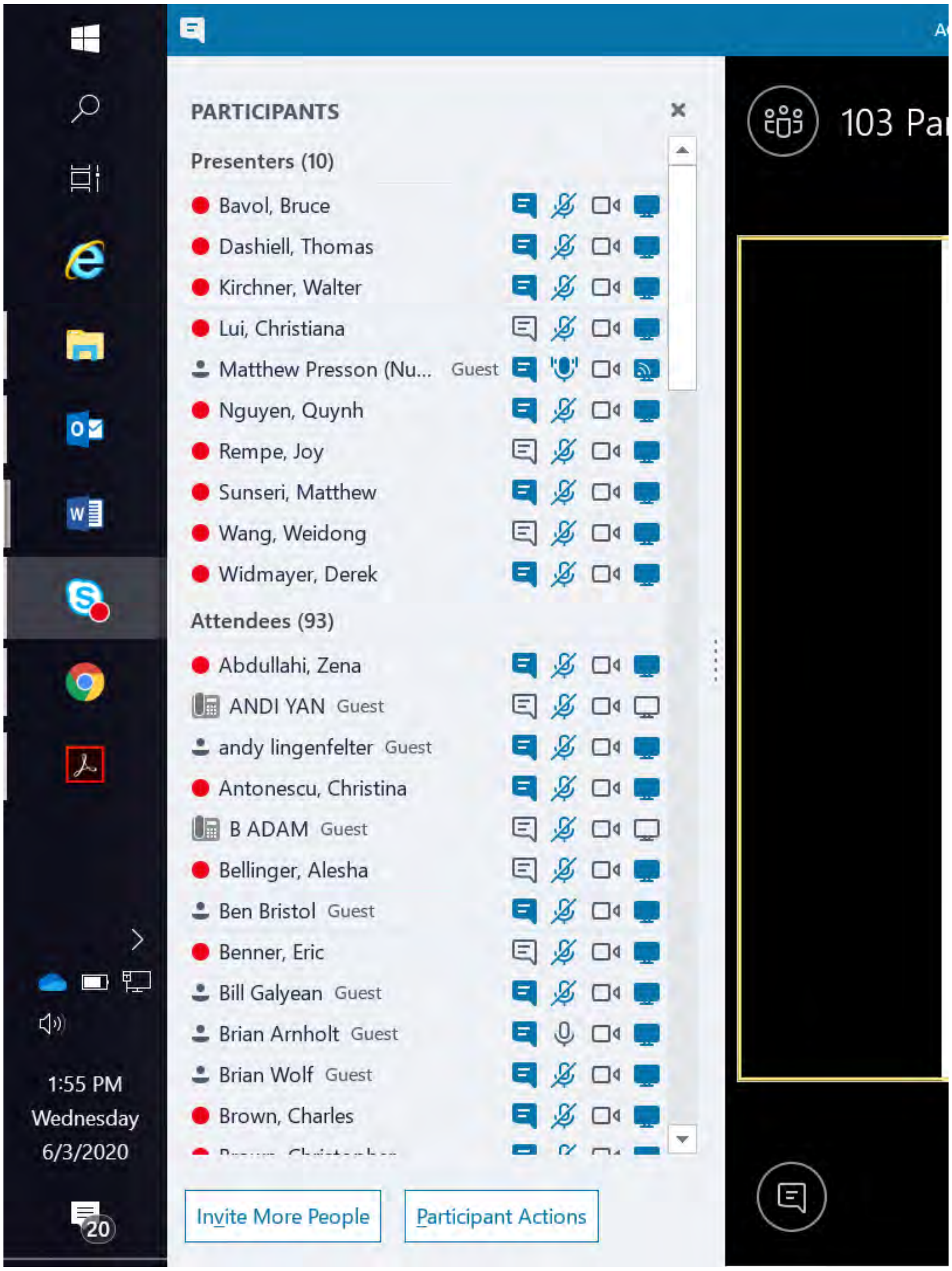
Impact – 2 Topical Reports:

- TR-0516-49416, Non-LOCA – (Non-Loss-of-Coolant Accident Analysis Methodology)
- TR-0516-49422, LOCA – (Loss-of-Coolant Accident Evaluation Model)

Next Step

The NRC Staff is currently completing its analyses and will engage with the ACRS in a technical briefing of their findings in July.

Questions?



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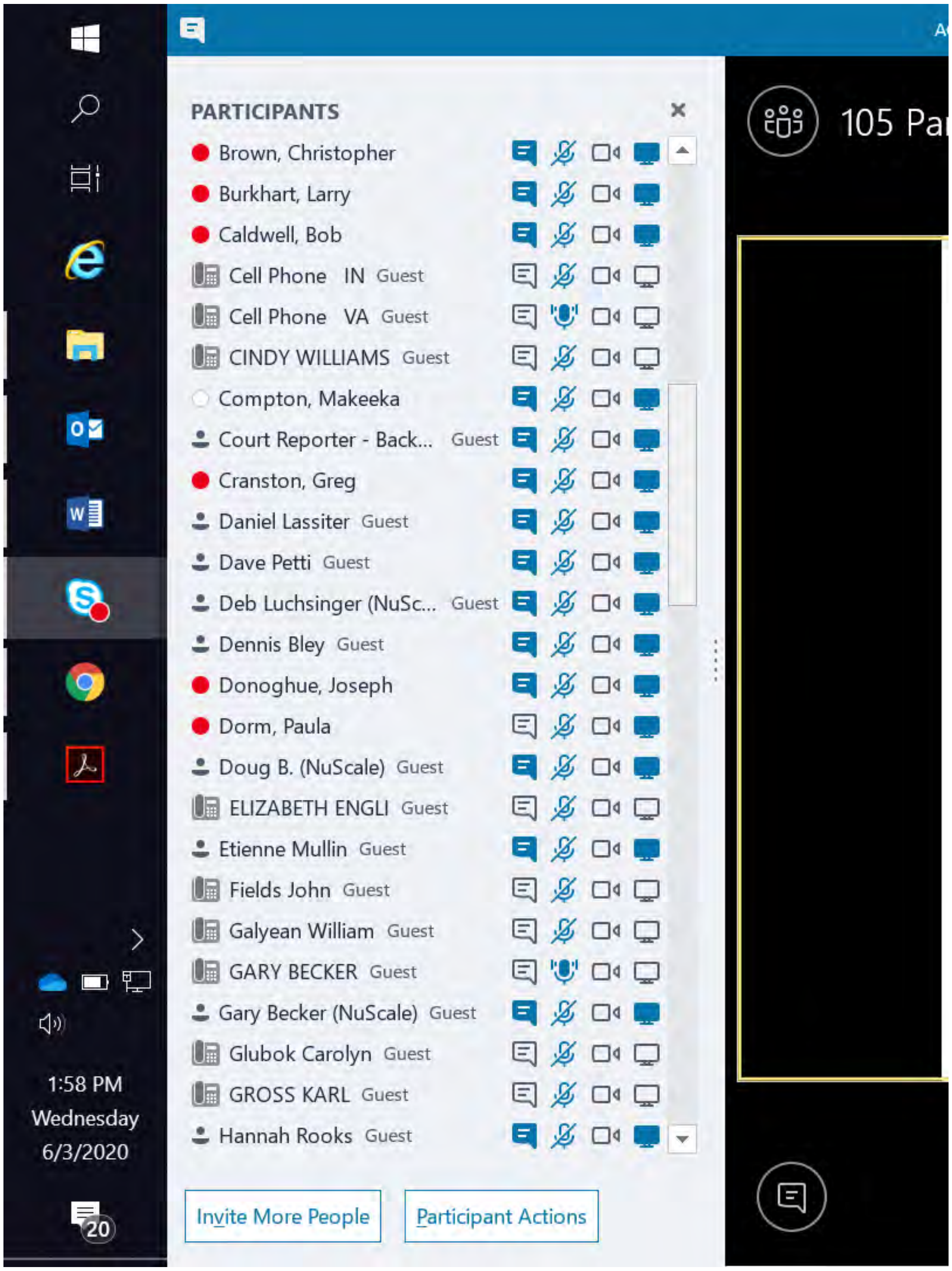
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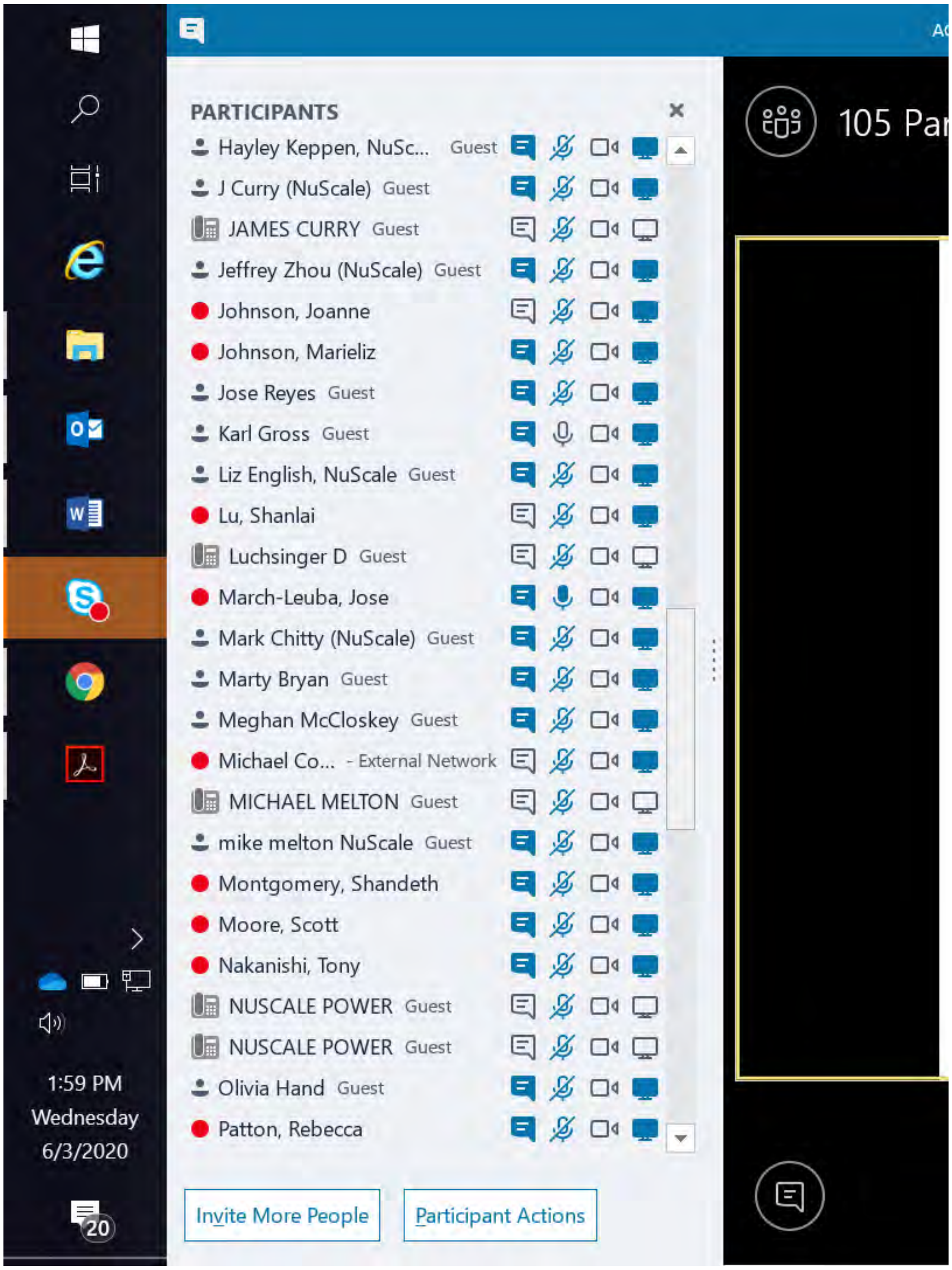
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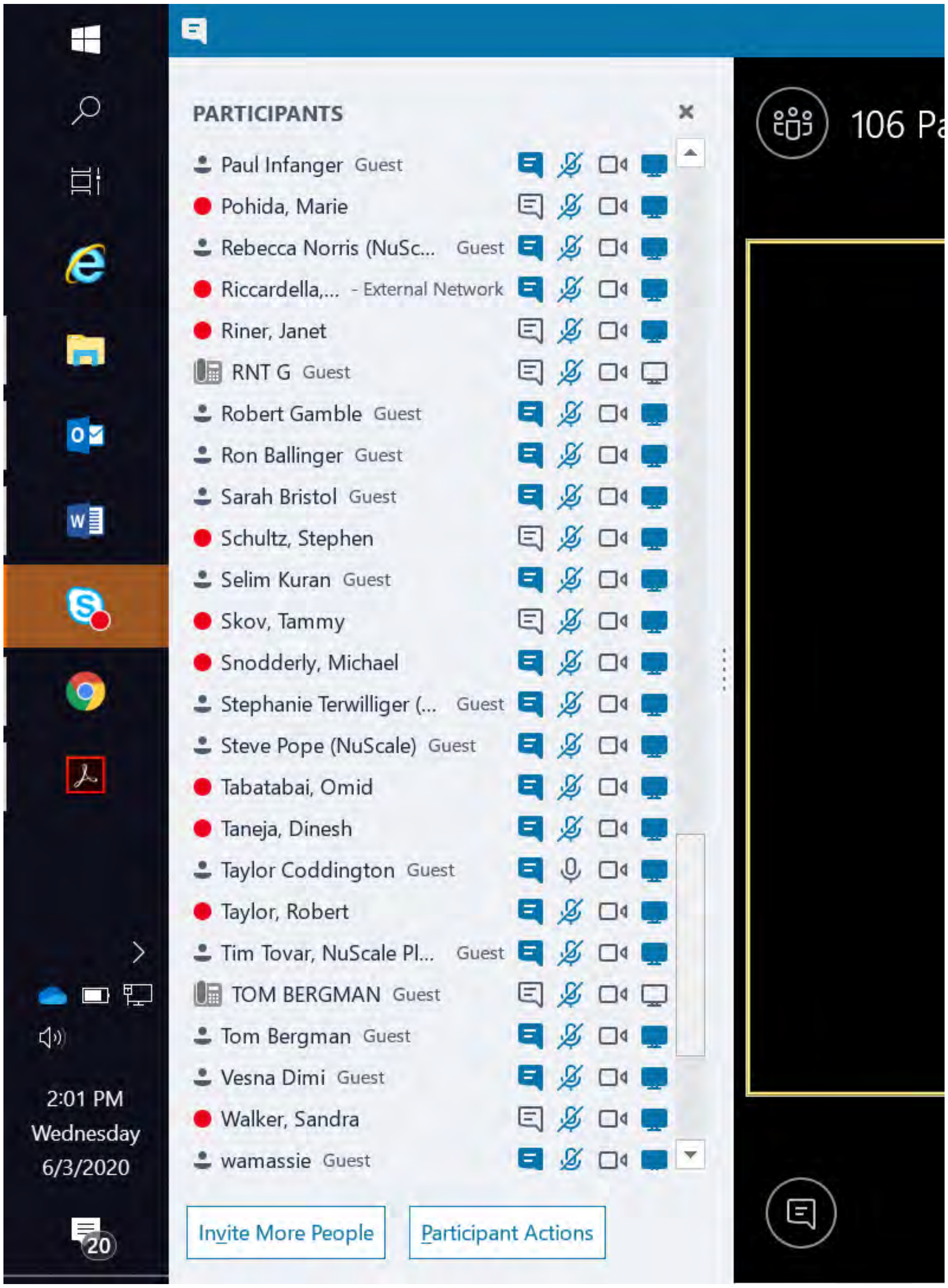
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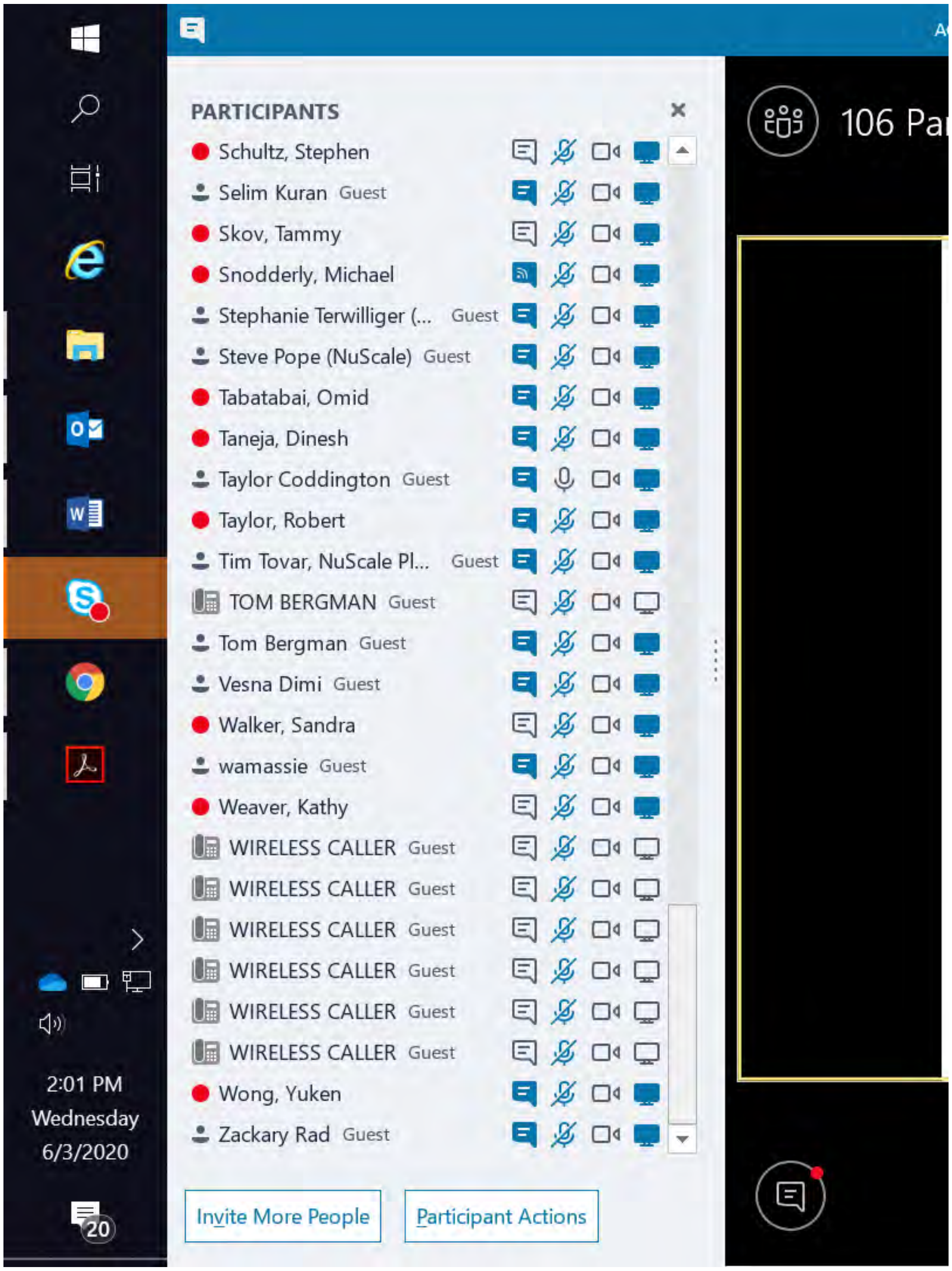
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NEI 96-07 Appendix D and RG 1.187 Revision 2

Eric Benner, NRR/DEX Director
Michael Waters, NRR/DEX/EICB
Philip McKenna, NRR/DRO/IRSB

Advisory Committee on Reactor Safeguards Meeting
June 3, 2020

Purpose

- Brief ACRS on:
  - The final versions of NEI 96-07 Appendix D and RG 1.187 Revision 2 (Recommendation 4)
  - How the exception in the draft RG on section 4.3.6 in NEI 96-07 Appendix D was resolved (Recommendation 3)

* Recommendations are from ACRS letter dated June 20, 2019, “Review of Nuclear Energy Institute (NEI) 96-07, Appendix D, “Supplemental Guidance for Application of 10 CFR 50.59 to Digital Modifications,” dated November 2018, and the NRC’s Associated Draft Revision 2 to Regulatory Guide 1.187, “Guidance for Implementation of 10 CFR 50.59 Changes, Tests and Experiments” (ML19171A323)

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NEI 96-07, Appendix D

Timeline After ACRS Full Committee Meeting:

- 06/25/19: Public meeting to conduct table-top exercises of digital I&C upgrades on applying Appendix D, Section 4.3.6 guidance (45-day RG 1.187 Public Comment period still open)
- 09/18/19: Public meeting on the comments received on RG 1.187, Revision 2. In addition, NRC offered draft wording to resolve the section 4.3.6 exception
- On 10/15/19 NEI provided revised section 4.3.6 wording
- From November 2019 to April 2020: Staff discussion on section 4.3.6 wording.
- On 4/22/20 NEI submitted final version of section 4.3.6 wording
- On 4/27/20 there was a public meeting to discuss NRC comments and suggestions on section 4.3.6 examples
- On 5/13/20 NEI submitted by letter the final version of Appendix D and requesting endorsement

50.59 Evaluation Criteria

- Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the FSAR (50.59(c)(2)(i))
- Result in more than a minimal increase the likelihood of occurrence of malfunction of a structure, system, and component (SSC) important to safety previously evaluated in the FSAR (50.59(c)(2)(ii))
- Result in more than a minimal increase in the consequences of an accident previously evaluated in the FSAR (50.59(c)(2)(iii))
- Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety accident previously evaluated in the FSAR (50.59(c)(2)(iv))
- Create the possibility of an accident of a different type than any previously evaluated in the FSAR (50.59(c)(2)(v))
- Create the possibility for a malfunction of an SSC with a different result than any previously evaluated in the FSAR (50.59(c)(2)(vi))
- Result in a design basis limit for a fission product barrier as described in the FSAR being exceeded or altered (50.59(c)(2)(vii))
- Result in a departure from a method of evaluation described in the FSAR used in evaluating the design basis or in the safety analysis (50.59(c)(2)(viii))

NEI 96-07, Appendix D (Rev. 0) Draft RG Exception

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e. Section 4.3.6 of NEI 96-07, Appendix D

The NRC staff takes exception to the application of the term "safety analysis" to the criterion in section 10 CFR 50.59(c)(2)(vi) in lieu of the term "FSAR (as updated)" throughout NEI 96-07, Appendix D, Section 4.3.6. This exception includes the Introduction to Section 4.3.6 of NEI 96-07, Appendix D, which does not itself provide guidance on the application of 10 CFR 50.59(c)(2)(vi) to a DI&C modification. Nonetheless, the NRC staff takes exception to the rationale set forth in the Introduction for

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limiting the matters considered under that criterion to safety analyses. In particular, the NRC staff takes exception to steps 5 and 6 in "Determination of Safety Analysis Result Impact," Section 4.3.6 of NEI 96-07, Appendix D, because the determination of the safety analysis result impact is only made against the safety analysis sections of the FSAR (as updated) and not against the entire FSAR (as updated). The NRC staff's position is that where the criteria in 10 CFR 50.59 uses the term "previously evaluated in the final safety analysis report," it means the whole FSAR (as updated). Therefore, when applying the guidance in Appendix D, licenses should not limit their examination of the FSAR (as updated) to particular sections. For example, Section 4.3.6 of Appendix D instructs the licensee to consider malfunctions previously evaluated in the safety analysis in their FSAR (as updated). Licensees should instead consider malfunctions previously evaluated in any section of their FSAR (as updated).

The text in Section 4.3.6 of NEI 96-07, Appendix D, allows the user to answer the question: "Does the Activity Create a Possibility for a Malfunction of an SSC Important to Safety with a Different Result?" However, contrary to NRC staff's interpretation of the guidance in NEI 96-07 and of 10 CFR 50.59, Section 4.3.6 of NEI 96-07, Appendix D, generally focuses on the impact of a malfunction on the results of the safety analysis rather than the impact on the results of the FSAR (as updated).

The NRC staff's position is that Section 4.3.6 of NEI 96-07, Appendix D, should determine whether the impact of the "SSC malfunction" has a different result than any previously evaluated in the FSAR (as updated), instead of a different result than previously evaluated in the "safety analysis" (Appendix D expresses the latter concept as "safety analysis results impact."). Therefore, Step 5 in Section 4.3.6 should be used to identify malfunctions previously evaluated in the FSAR (as updated) and the results of these malfunctions. Step 6 in Section 4.3.6 should be used to compare the projected/postulated results with the previously evaluated results to determine whether the effects are bounded by the results in the FSAR (as updated).

Examples 4-17 through 4-23 of NEI 96-07, Appendix D, use the term "safety analysis" based on the explanation in the introduction of NEI 96-07, Appendix D, Section 4.3.6, rather than using the UFSAR. This can result in an incorrect 10 CFR 50.59 evaluation. For instance, in example 4-19, which discusses an upgrade of area radiation monitors, the NRC staff takes exception to the text: "There are no safety analyses that directly or indirectly credit this design basis function. Namely, there are no considerations of malfunctions of single or multiple radiation monitors, or expected responses of the radiation monitors, in any safety analysis." The NRC staff's position on example 4-19 is that the user should identify area radiation monitor malfunctions previously evaluated in the FSAR (as updated) and the results of these malfunctions. The results should be compared with previously evaluated results to determine whether the effects are bounded by the results in the FSAR (as updated), and not solely the results in the safety analysis. Stating that there cannot be a different result when comparing to a preexisting safety analysis because none exists is not adequate to meet 10 CFR 50.59.

NEI 96-07, Appendix D Path to Resolution

Public Meeting Conducted on 6/25/19:

Purpose was to conduct a table-top exercises of digital I&C upgrades in which applying NEI 96-07, Appendix D, Criterion 6 guidance was met.

Public Meeting Conducted on 9/18/19:

Purpose was to discuss the public comments received on the draft RG.

NEI 96-07, Appendix D Section 4.3.6 (Revision 1)

- Six Step Process in Section 4.3.6 Revised Wording
  1. Identify the functions directly or indirectly related to the proposed modification
  2. Identify which of the functions from Step 1 are Design Functions and/or Design Basis Functions
  3. Determine if a new Failure Modes and Analysis (FMEA) needs to be generated
  4. Determine if each design bases function continues to be performed/satisfied
  5. **Identify all ~~safety analyses~~ involved malfunctions of an SSC important to safety previously evaluated in the UFSAR**
  6. **For each ~~safety analyses~~ involved malfunction of an SSC important to safety, compare the projected/postulated results with the previously evaluated results**

Clarifications

RG 1.187 Revision 2 endorses NEI 96-07 Appendix D with clarifications

Relationship to NEI 01-01: the NRC continues to find NEI 01-01 acceptable for use by NRC licensees. Licensees have the option to use the 10 CFR 50.59 guidance provided in either NEI 01-01 or in NEI 96-07, Appendix D, Revision 1. However, NEI 96-07, Appendix D, Revision 1 does not describe, and this revision to RG 1.187 (Revision 2) does not endorse, applying select portions from both NEI 96-07, Appendix D, Revision 1 and 10 CFR 50.59 guidance of NEI 01-01. In addition, NEI 96-07, Appendix D, Revision 1 is applicable to digital modifications only and is not generically applicable to the 10 CFR 50.59 process. **(Reworded slightly from the draft RG)**

Clarifications

Human-System Interface:

- In NEI 96-07, Revision 1 changes to HSI automatically screened in.
- NRC has endorsed contradicting guidance in NEI 01-01, which states, "not all changes to the human-system interface fundamentally alter the means of performing or controlling design functions," and therefore NEI 01-01 advises that not all changes to HSI should automatically screen in.
- NEI included similar guidance on screening for HSI in Appendix D.
- The NRC staff acknowledges that Appendix D is thus not a change from existing guidance on digital interfaces, but notes that it is a change from the guidance in NEI 96-07, Revision 1. The NRC staff agrees that changes to HSI may be screened as described in NEI 96-07, Appendix D, Revision 1. (**Reworded from the draft RG**)

Clarifications

Software Failure

- RIS 2002-22 Supplement 1 is currently the only guidance the NRC has reviewed or endorsed as providing an acceptable technical basis to determine that the likelihood of software CCF is sufficiently low for the purpose of 10 CFR 50.59 evaluations and may be used in conjunction with NEI 96-07, Appendix D, Revision 1.

Clarifications

Use of Acceptance Criteria as Evaluation Results:

- NEI 96-07, Revision 1, Section 4.3.6, in contrast to Appendix D, does not refer to "acceptance criteria"
- NEI 96-07, Revision 1, provided that licensees should consider changes to SSCs at the same level at which malfunctions of the affected SSCs were previously evaluated in the FSAR (i.e., component- or system-level).
- The NRC has now determined that, in addition to the existing guidance in NEI 96-07, Revision 1, licensees may consider whether all applicable acceptance criteria are satisfied after a proposed change to demonstrate that no possibility for a malfunction with a different result has been created. (**New Clarification**)

Clarifications

Step 6: Basic Assumptions and Acceptance Criteria

"For those design functions placed into [categories 1.b, 2.b, or 3 in Step 2], if any of the previous evaluations of involved malfunctions of an SSC important to safety have become invalid due to their basic assumptions no longer being valid (e.g., single failure assumption is not maintained), or if any existing safety analysis is no longer bounding (e.g., the revised safety analysis no longer satisfies the acceptance criteria identified in the associated safety analysis), then the proposed activity creates the possibility for a malfunction of an SSC important to safety with a different result. [Emphasis added.] "

(New Clarification)

NEI Comments on RG 1.187 Rev 2 (From ACRS Subcommittee Mtg)

- Appears to unnecessarily insert the purpose of Criterion 8 in the consideration of Criterion 6. **Resolution: Clarification 2.d was revised to remove Criterion 8 language.**

- May not fully account for revised Section 4.3.6 guidance. **Resolution: Clarifications 2.d was revised.**

- May imply that RIS 2002-22, Supplement 1 must be used in a broader population of DI&C activities than intended. **Resolution: Clarification 2.c was revised.**

- The two-prong test has been the way that licensees having been doing 50.59 evaluations even though it is not stated in NEI 96-07, Revision 1. **Resolution: Clarification 2.c retains this language, but it is slightly modified.**

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Questions ?

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Back-Up Slides

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NEI 96-07, Appendix D

Timeline Through ACRS Full Committee Meeting:

- In July 2018, NEI provided an update to NEI 96-07, Appendix D
- In August 2018, the NRC staff provided a set of comprehensive comments (85 total) to NEI, and began a disciplined process for cataloging and tracking comments for resolution
- Public meetings were held with industry on 8/30/18, 9/11/18, 10/11/18, and 11/14/18 to resolve these comments. Over 90% of the comments were resolved using this process
- NEI submitted its final revision of NEI 96-07, Appendix D to the NRC on 11/30/18. Letter requesting endorsement submitted 1/08/19
- ACRS Digital I&C Subcommittee meeting on 4/16/19
- Draft RG 1.187 Rev. 2 was issued for public comment on 5/30/19
- ACRS Full committee meeting on 6/5/19

NEI 96-07, Appendix D, Section 4.3.6 (Rev 1)

Acceptance Criteria Language in Step 6 Changed:

- For those design functions placed into any other category or combination of categories, if any of the previous evaluations of involved malfunctions of an SSC important to safety have become invalid due to their basic assumptions no longer being valid (e.g., single failure assumption is not maintained), or if any existing safety analysis is no longer bounding (e.g., the revised safety analysis no longer satisfies the acceptance criteria identified in the associated safety analysis), then the proposed activity creates the possibility for a malfunction of an SSC important to safety with a different result. If the acceptance criteria are still satisfied and the basic assumptions remain valid, there is no different result even if the malfunction of an SSC important to safety would otherwise cause changes to input parameters described in the USFAR.

NEI 96-07, Appendix D Path to Resolution

Example of Acceptance Criteria: (Example 4-18)

- Previously, only one of four feedwater flow control valves was assumed to fail open as part of the initiation of the Excess Feedwater event. Now, as a result of this change, all four feedwater flow control valves could simultaneously fail open following a software CCF.
- Step 6: The severity of the initiating failure has increased due to four valves supplying flow as compared to one valve prior to the change.
- The minimum acceptable departure from nucleate boiling ratio (DNBR), i.e., the acceptance criteria identified in the associated safety analysis, is 1.30. The current safety analysis documents a minimum DNBR value equal to 1.42. After using the increased value for the new feedwater flow (to represent the increase in feedwater flow caused by the opening of the four feedwater flow control valves) in a revision to the Excess Feedwater accident analysis, the new safety analysis documents a minimum DNBR value equal to 1.33.
- Conclusion: Although the software CCF likelihood was determined to be **not sufficiently low** and the severity of the initiating failure has increased, a comparison of the minimum DNBR values shows that the safety analysis remains bounded by the associated acceptance criteria. Therefore, the proposed activity does NOT create the possibility for a malfunction of an SSC important to safety with a different result.

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NEI 96-07, Appendix D

- RIS 2002-22, Supplement 1 gives guidance on the technical aspect of digital I&C modifications, not the 50.59 process
- Appendix D gives digital I&C modification screening and evaluation guidance
- The format of Appendix D is aligned with NEI 96-07, Rev. 1 text for ease of use
- Some of the guidance in Appendix D is not digital specific
- NEI 96-07, Appendix D does incorporate some RIS 2002-22, Supplement 1 guidance on qualitative assessments

RIS 2002-22, Supplement 1

- NRC issues RIS 2002-22, Supplement 1 in May 2018 to clarify RIS 2002-22
- NRC continues to endorse NEI 01-01
- RIS 2002-22, Supplement 1, clarifies guidance for preparing and documenting “Qualitative Assessments”
- Not for Replacement of:
  - Reactor Protection System (wholesale)
  - Engineered Safety Features Actuation System (wholesale)
  - Modification/Replacement of the Internal Logic Portions of These Systems
- Licensees can currently performed digital modifications using RIS 2002-22, Supplement 1 guidance (without an NRC endorsed NEI 96-07, Appendix D)

NEI 96-07, Appendix D Screening Section

- Scope of digital modifications:
  - Software-related activities
  - Hardware-related activities
  - Human-System Interface-related activities
- To reach screen conclusion of non-adverse:
  - Physical characteristics of the digital modification
    - Change has limited scope
    - Relatively simple digital architecture
    - Limited functionality
    - Can be comprehensively tested
  - Engineering Evaluation Assessments
    - Quality of the design process
    - Single failures encompassed by existing failures of the analog device
    - Has extensive operating history

NEI 96-07, Appendix D Screening Section

- Combination of Components/Systems and/or Functions
  - Mere act of combining does not make the screen adverse
  - If it causes an adverse act on the design function, then adverse
  - Reductions in the redundancy, diversity, separation, or independence of a UFSAR design function screen adverse

- Human Factors Engineering Evaluation
  - NEI worked closely with NRC human factors personnel on this section
  - Two steps:
    - Identify generic primary tasks involved
    - For all primary tasks, assess if the mod negatively impacts the primary task

NEI 96-07, Appendix D Evaluation Section

- Guidance in sections 4.3 aligns with main body of NEI 96-07 and there is a caution that Appendix D is intended to supplement guidance in main body of NEI 96-07
- Sections 4.3.1, 4.3.2, 4.3.5, and 4.3.6 (which align with the Criterion in the evaluation paragraph of 10 CFR 50.59) (50.59(c)(2)) discuss the use of the qualitative assessment outcome (sufficiently low or not sufficiently low) to answer the evaluation questions
- Sections 4.3.3 and 4.3.4 state that they provide no new guidance for digital modifications
  - More than a minimal increase in the consequences of an accident
  - More than a minimal increase in the consequences of a malfunction

NEI 96-07, Appendix D Evaluation Section

- Guidance in section 4.3.6 (Does the Activity Create a Possibility for a Malfunction of an SSC Important to Safety with a Different Result):
  - Discussion on design basis functions
  - Connection between design basis functions and safety analysis result