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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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710TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY

NOVEMBER 2, 2023

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The Advisory Committee met via Video Teleconference, at 8:30 a.m. EDT, Joy L. Rempe, Chairman, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chairman

WALTER L. KIRCHNER, Vice Chairman

DAVID A. PETTI, Member-at-Large

RONALD G. BALLINGER, Member

VICKI M. BIER, Member

CHARLES H. BROWN, JR. Member

VESNA B. DIMITRIJEVIC, Member

GREGORY H. HALNON, Member

JOSE MARCH-LEUBA, Member

ROBERT P. MARTIN, Member

THOMAS E. ROBERTS, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

DENNIS BLEY

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

ZENA ABDULLAHI

ALSO PRESENT:

PHILIP BENAVIDES, NMSS

JAMES CORSON, RES

ELIJAH DICKSON, NRR

SCOTT KREPEL, NRR

LISETTE MADALENA, Interpreter

JOSEPH MESSINA, NRR

CHARLEY PEABODY, NRR

JASON PIOTTER, NMSS

ASHLEY SMITH, NRR

JENNIFER WAGNER, Interpreter

P R O C E E D I N G S

8:30 a.m.

CHAIR REMPE: So good morning. It's 8:30 on the East Coast, and this meeting will now come to order. This is the second day of the 710th meeting of the Advisory Committee on Reactor Safeguards.

I'm Joy Rempe, Chairman of the ACRS. Other members in attendance are Ron Ballinger, Vicki Bier, Vesna Dimitrijevic, Greg Halnon, Walt Kirchner, Jose March-Leuba, Robert Martin, Dave Petti, Tom Roberts, Matthew Sunseri. And we'll soon be joined I'm sure by Member Brown. He's probably delayed in traffic.

I note we have a quorum. Similar to yesterday, the committee is meeting in person and virtually. A communications channel has been opened to allow members of the public to monitor the committee's discussion. Ms. Zena Abdullahi is the Designated Federal Officer for today's meeting.

During today's meeting, the committee will consider the following topic: increased enrichment rulemaking regulatory basis. It's requested that speakers identify themselves and speak with sufficient clarity and volume so they can be readily heard.

Additionally, participants should mute

themselves when not speaking. At this time, I would like to ask other members if they have any opening remarks. And not seeing or hearing any, then I'd like to ask Member Ron Ballinger to lead us in our first topic for today's meeting.

Ron.

MEMBER BALLINGER: Thank you, Chairman. I would like to make a few opening remarks.

Today's presentation is going to be -- is a bit unusual. At our subcommittee meeting we had a lot of questions and answers back and forth on this topic, especially related to FFRD. And subsequent to that, we've had a few conversations back and forth.

And so the staff's presentation today will be more -- in more detail than we would expect for a full committee meeting to make sure that members that were not present at the subcommittee are completely up to speed on the issues and have their opportunities to ask questions.

And our options, usually wait until after the presentation for the discussion. Our options are likely to be write a letter today or at this time, but public comments have not been received, primarily from industry, on this document. And they have not been incorporated into the document but will be

incorporated when the rule is issued. Those comments will be incorporated.

So we have not had the advantage of having those comments for our deliberation. So the second option would be to wait until the rule, draft rule is issued, where we get another chance to review it. At which time, the industry public comments would be incorporated.

So that's where we are. That time would be well into 2024, I think, if we choose to do that. So members, please keep these options in mind as we listen to their presentation, and hopefully the discussions after that will be -- will give us some idea on the best path forward.

So I don't know whether the staff wants to make an initial statement or not.

MR. KREPEL: This is Scott Krepel speaking through a sign language interpreter. I am the Branch Chief of the Nuclear Methods and Fuel Analysis Branch, and I'm happy to see all of you in person again. So I will give some short remarks. I don't want to take up too much of our time.

But the increased enrichment rulemaking has been approved to move forward for the regulatory framework in order to support industry and a federal

goal of moving towards a carbon-free economy. This is a significant initiative for a lot of people, and this effort involves multiple offices and divisions throughout the NRC.

My branch is only one specific section of it for fuel fragmentation, relocation, and dispersal. But I've heard that's what's made most people excited.

And I want to emphasize that we are making no recommendation in the reg basis. Because we believe that this is so important and complex that we needed to get -- we need to get stakeholders' input before moving forward with a recommendation.

But to be honest, we threw everything into the kitchen sink in this reg basis in order to consider a wide range of different options. I look forward to hearing what you all have to say after my staff provides their presentation, and thank you for giving me the opportunity to provide some remarks.

CHAIR REMPE: Ron?

MEMBER BALLINGER: Yes, ma'am.

CHAIR REMPE: When we had our subcommittee meeting, we heard there was going to be a meeting on October 25 --

MEMBER BALLINGER: Yeah, I was about to mention.

CHAIR REMPE: And yeah, I don't see anything in the slides about it. And yes, I think it would be better than just looking at it and trying to interpret and reading the transcript what the staff thinks. Did they get some significant comments --

MEMBER BALLINGER: They did.

CHAIR REMPE: From industry at that time, and could the staff or perhaps Scott provide us their thoughts about those industry comments? Were there a lot of people saying hey, wait to publish this regulatory basis until you hear our official comments? Did you -- or did they say yeah, this looks pretty good? Or what happened?

MEMBER BALLINGER: I mentioned that to them and asked if we can get access quickly to the results of that public meeting. Because there were public comments by the industry.

CHAIR REMPE: Okay, well, I'd like to hear it, not just have access to it because we're supposed to be starting the letter-writing today. So I hope the staff will include this in their discussions today, because I don't see any slides on that.

MR. BENAVIDES: Yeah, we did receive some comments. Most of the questions that came, they're more clarity, trying to understand what the regulatory

basis or the process forward. I don't know if some of the tech staff, I know we have Elijah and Joe Messina here, Elijah Dickson and Joe Messina here, that maybe their topics. Because there's more I guess questions related to their topics.

But the regulatory basis is published. Just kind of where we are in that, it's published. This is part of our normal process. This is the clarity.

Really, it was an introduction of hey, this is work we did in the public meeting, you know, in the regulatory basis. And then it was inform the public on how to go forward to provide, you know, comments to be considered as we developed the proposed rule.

And so a lot of the feedback was on that. There were some clarifying questions, so --

CHAIR REMPE: I'll be a little more specific. Your regulatory basis document said you were waiting to finalize your recommendation for FFRD until you receive public input so you can consider those comments and determine if any changes need to be made or if you can make a recommendation.

Did you receive enough comments in the public meeting to move forward on that finalization of

your recommendation?

MR. BENAVIDES: No, we have not.

CHAIR REMPE: Okay.

MR. BENAVIDES: Because we'll receive those, the public comment period, which is going -- scheduled today, as of November 22. We did receive an extension request that we're evaluating. That would be for an additional two months. And so we will -- what we typically do as part of the process is we wait for those comments to come in and hold.

Because we recognize that while a lot of parties are engaged and want to be there at the public meetings, there are others that provide input that may not be available that day. And so we will wait for that comment period to close before we consider and move forward.

CHAIR REMPE: Thank you.

MR. BENAVIDES: You're welcome.

MR. KREPEL: And this is Scott. I just want to say something really quickly. Typically an organization like NEI will provide their public comment on the final day. And they'll take a lot of -- they take a lot of time to collect feedback from different stakeholders and discuss amongst themselves.

So it could be close to the final time

period before they actually get comments. And we won't know enough until the final day until the public comment time period is over.

MR. BENAVIDES: And just to add onto that, as part of the request we received for the public extension request that there's — industry did desire more time to evaluate the topics. Because we are asking a lot of questions, especially in the FFRD and the control room design criteria, and industry wanted to have time to digest that, consider it, and be able to respond appropriately.

CHAIR REMPE: Thank you.

MEMBER BALLINGER: Okay, we can proceed, I think.

MR. BENAVIDES: Next slide, please.

MEMBER BALLINGER: You'll have to hunker up to the microscope, or to the --

MR. BENAVIDES: Sorry. Thank you for your time. I'm Phil Benavides, I'm the project manager in the Office of Nuclear Materials Safety and Safeguards, project manager for this rulemaking on the increased enrichment conventional and accident-tolerant fuel designs in light water reactors.

Today we are going to provide an overview of the increased enrichment regulatory basis, which

was noticed in the Federal Register on September 8. The overview will begin with a brief overview of the increased enrichment rulemaking, which will be in the presentations from the relevant subject matter experts for each of the regulatory basis technical topics. Next slide, please.

With that, I'm going to provide an overview of the increased enrichment rulemaking. Slide 5, please.

As a reminder, this slide shows our typical rulemaking process. We are still in the second box, denoted by the yellow star, where we have issued a regulatory basis on September 8 and are in the public comment period.

I wanted to use this slide to point out that the team is engaging with ACRS earlier than normal, due to the complexity of this rulemaking. This engagement along with public comments received will help inform the development of the proposed rule.

With that said, I do want to point out the additional opportunities for ACRS engagement, denoted by the blue triangles. ACRS will have, as you know, ACRS will have an opportunity to engage in the proposed rule prior to the rule being sent up to the Commission for consideration.

In addition, ACRS will have an opportunity to engage towards the end of the final rule development, which will be prior to the final rule being sent to the Commission for consideration as well. Next slide, please.

As a way to provide background on how we got to this point, I'd like to go back to the beginning when the issue was identified. Throughout the last few years, staff has seen an increased interest from industry for the use of fuel enriched above 5%, U-235.

The NRC noted that although the current regulatory framework allows for the licensee to fuel above 5 weight percent, the use of this fuel may result in numerous exemption requests for licensees.

So as a proposed solution, NRC staff began pursuing rulemaking rather than licensing by individual exemption. In December of 2021, the staff provided the Commission with SECY-21-0109, requesting approval to begin the rulemaking process. The Commission granted this approval in SRM-SECY-21-0109 in March of '22, 2022.

The Commission also specified several considerations to evaluate in addition to what was specified in the rulemaking plan. These are

addressed, fuel fragmentation, relocation and dispersal. Take a risk-informed approach. And we should also engage with stakeholders to develop the regulatory guidance.

Slide 7 --

MEMBER MARTIN: Question.

MR. BENAVIDES: Sure.

MEMBER MARTIN: From Member Martin. Like understand implications of a kind generic resolution. In my experience, generic can go a couple paths. One, you can just put something generic and put the burden on the applicant. Or normally, you might try to solve a lot of problems at a time.

And if you do that, obviously there's a lot of up-front costs, you know, due diligence on that. What is your vision, or what do you mean by generic in this particular case? Is it just, you know, another catchphrase to eliminate the exemption approach that, you know, and you're just using it kind of at a high level?

Or anyway, just explain. It comes up a few times in the report, so.

MR. BENAVIDES: Okay. You're talking about the -- and just to make sure, I will repeat back. Our approach forward with this rulemaking, what

we do to avoid those exemptions going forward.

With those in a lot of the topics we do have, we're going to change the rules where there -- where there's areas where -- in the regulations where there's caps at 5%. We're going to evaluate those and make sure that is appropriate to raise them beyond 5% up to less -- up to but less than 20%.

And so for example, in 71.55, you know, we're looking at a portion of that where it's in there. And we're realizing that, you know, maybe it's not needed. Or in 50.68 for the criticality one, you know, requirements, the 5% criteria.

We're looking at that. I think the path forward with that is to -- the path forward with that is to remove the 5% and really point to the k-effective being less than .95, you know, .95. You know, and kind of looking at the criteria that may be more --

MEMBER MARTIN: I think the rub, Bob, is that it gets into the fuel dispersion (audio interference) and whether something gets snuck in there and then is there -- I see a lot of statements about research, your research.

And you start thinking -- you know, piecing the generic and research, and they start

seeing a process that goes way out in time. And at the same, generic doesn't include non-light water reactors. That's explicit in the report.

So anyway, there's an ambiguity I think with the term and that I'm responding to. But yes, if we go back to the SECY, it says something to the effect that it's generic so that it's a, you know, a more straightforward process that we get through quickly.

And I guess when I saw the research aspect to it, I started to wonder whether, you know, it was a little bit of scope creep coming into play.

MR. BENAVIDES: Right, and you know, I would point out the FFRD topic was not part of the rulemaking plan that went --

MEMBER MARTIN: Okay.

MR. BENAVIDES: And so that is something that the staff has done a great job. And they're trying to manage that. But as with our regulatory basis, we put forth there proposed alternatives that the staff has come up with for consideration.

But we have put out for the public to provide, you know, feedback on that so we can be informed as we move forward with --

(Simultaneous speaking)

MEMBER MARTIN: It's good to know what you said there in 21, that the fuel dispersion wasn't necessarily part of that earlier vision, but now it's in there. For good reason. But there is a little bit of added risk introduced. Thank you.

MR. BENAVIDES: No, thank you. All right, thank you, we're on slide 7.

Just the status of the rulemaking activity. The NRC issued the regulatory basis on September 8, as stated earlier.

This regulatory basis discusses the regulatory issues, alternatives, and new alternatives to resolve them. Considers legal, policy, and technical issues. Considers the cost and benefits of each alternative. And identifies the NRC staff's recommended alternative in most regulatory issues, with the FFRD being an outlier, which will wait for additional public input received during the public comment period.

Stakeholder involvement includes public meetings, which were held in June 22 of 2022 and last week, October 25, and the public period, which is currently open 'til November 22. Once again, I'd like to point out that we have received an extension request that is under consideration.

And then just to point out, just per the timeline, the proposed rule is due to the Commission December 2024.

VICE CHAIR KIRCHNER: Philip, maybe this is a good to follow on Bob's comments. For the court reporter, this is Walt Kirchner.

When you say generic, what I'm thinking of is you look at the existing regulations that are applicable to the issue of what level of enrichment. And on your previous slide, you made it clear you were dealing with LWRs.

But if you do this generically, and I am advanced reactor concept, then I can point to these changes in the rules, whether it shows up in 50 or 52 or shows up in the 70 series, or wherever enrichment is addressed in the existing reg structure. Then I'm okay.

What bothers me is the constant LWR for every -- not just for your activity, but we see this across the board. We get this distinct non-LWR proposals and LWR proposals. But if this is truly generic, then this just opens the door for anyone who wants to go way up to 20% enrichment, or whatever level you set in your rulemaking.

MR. BENAVIDES: Yeah, the rulemaking is

focused on light water reactors.

VICE CHAIR KIRCHNER: No, I understand that, yeah. But when you changed the regulations, that opens the door for non-LWRs to take advantage, avail themselves of that. Is that correct? Yeah.

MR. BENAVIDES: Yeah.

VICE CHAIR KIRCHNER: Yeah, okay, fine. So it is generic in that sense. Right, okay, go on. Thank you.

MR. BENAVIDES: Okay. Next slide, please. And here's the topics, regulatory basis topics that will be discussed in detail by our NRC subject matter experts. Charlie Peabody will discuss criticality and accident requirements in 10 CFR 50.68.

With Don Palmrose unavailable today, I'll provide a brief overview of both environmental topics in 10 CFR 51.51 and 51.52. Jason Piotter will discuss general requirements for fissile material packages in 10 CFR 71.55.

Elijah Dickson will discuss control room requirements in 10 CFR 50.67 and GDC-19. Joe Messina and Ashley Smith will discuss the topic of fuel dispersal.

And with that, unless there are any additional questions on the rulemaking overview, we

can move on to the technical topic presentations.

All right, thank you for your time. Hearing none, Charlie Peabody will present on 50.68.

MR. PEABODY: All right, this is Charlie Peabody. Can everyone hear me?

SPEAKER: Yes, you're fine.

MR. PEABODY: All right, next slide, please, Aaron.

So the area I looked at was 10 CFR 50.68. This is a rule that essentially uses k-effective acceptance criteria with required probability and confidence levels to permit exemptions to 70.24 activity criticality monitoring and emergency planning requirements.

This rule has a condition in it. It's 50.68(b)(7), which limits the application of this rule to 5 percent weight U-235. This limit is, you know, distinct from the B(2), B(3) and B(4) paragraphs, which are the ones that actually specific the k-effective acceptance criteria.

I want to be clear that like we're looking at changing the enrichment paragraph, but we plan on maintaining the k-effective acceptance criteria at their existing criteria, probability, and confidence levels. Next slide.

MEMBER MARTIN: Question. This Bob Martin again. The 5%, the original basis for the 5% enrichment limit I would think, in part, given how old it is probably, that there was some testing done, criticality testing or at least some sort of database. And it would have covered up to 5%. Maybe it addressed certain handling scenarios, what have you.

What little I know about testing and criticality, I don't think there's a ton of testing beyond 5%. Have you thought about the necessity for looking at this question of criticality testing for higher enrichments?

MR. PEABODY: So when you used the term testing, you know --

MEMBER MARTIN: Physical testing.

MR. PEABODY: Yeah, we are doing a research study that, you know, models the higher enrichments, but we haven't done physical testing on this. In part because, you know, we don't readily have access to material that's enriched beyond 5%. And many of the other parts of this rule will facilitate, you know, that becoming more available.

I will just say, like I've kind of thought about too, you know, like if -- as you do extrapolate out, you know, with the calculations, at some point it

might just be easier to actually do a physical test to determine what your multiplication is in the spent fuel pool and apply it to the same limit. But that's not what we've been seeing so far.

And also, if we go on to the next slide just for this particular point, the way that we analyze and apply 50.68 as part of our fuel transition LAR process, so it's something that we look at in advance.

A licensee would have to furbish a -- or I'm sorry, an applicant would have to furbish a justification that they can safely apply 5 percent weight in their new and spent fuel storage facilities before we approved their use of that fuel and let that fuel be delivered to their site.

MEMBER MARTIN: So to follow up, there's a possibility that the applicant might need to, say, invest in some criticality testing. I mean, because codes, I'm a code guy my whole life, but codes lie. And there's nothing better than testing.

But would you agree that there's the possibility that there might be some burden associated with criticality testing? I mean, we already know there's going to be some burden with fuel designs anyway, there always has been an issue.

MR. PEABODY: Yeah, another particular with that is that, you know, the codes are always going to assume that the spent fuel pool is completely up to whatever their maximum capacity is on this.

And like even if you could get some testing measurements, it may, like it's going to produce the same output, but it may not -- it may only validate part of the code. It may not validate the entire code. So that's another challenge with that.

But obviously the active criticality monitoring part of this is what initially led to the 50.68 methodology, and that was implemented in 1998, to kind of give you an idea of the timeframe that this research was performed.

Like, if the whole point of it is to have -- is to not have to have active criticality monitoring, then obviously like performing that test kind of becomes the thing that they wanted to avoid.

So if they have that, then the only real gain from this is that they wouldn't have to do some of the emergency planning drills if they could demonstrate that the criticality -- that the margin to criticality was below the acceptance criteria.

MEMBER MARTIN: Thank you.

MR. PEABODY: All right, Aaron, next

slide. So we're recommending Alternative 3 in the reg. base, which will replace the current enrichment limit 50,58, paragraph B(7), with the tech spec design features limit. This requirement is also featured in tech spec 4.3, the design feature section.

This will have the advantages of maintaining existing sub-criticality margins at the same probability and confidence levels. The criticality safety impacts will continue to be addressed during the fuel transition license amendment request process, and it will be looked at in advance of the application by the NRC staff.

It will allow us to consider low-enriched uranium up to 20 percent weight. We are doing a criticality research study with Oak Ridge National Laboratory just to verify that the increased enrichment will be capable of being addressed with existing technologies, particularly integral fuel burner absorbers coatings and gadolinium rods.

We're also, I think it's important to note that this will preserve 50.68 compliance for all of the existing fleet without the fact that because essentially when they increase enrichment beyond 5%, that becomes a voluntary initiative on their part. But they're still able to continue applying at any

current existing enrichment levels that they're approved for without additional licensing actions.

That's all I had on --

(Simultaneous speaking)

MEMBER MARTIN: I'm going to hog the floor on this. Just a simple question. So basically, 50.68 is being proposed without a limit, with this statement here, replacing the current enrichment limits with a tech spec, design features. So that'd be, again, on the applicant.

MR. PEABODY: Yes, it would be --

MEMBER MARTIN: Is there any need for, like from a proliferation perspective? Is there going to be a guardrail at some higher level? I mean, I have no experience in that, but.

MR. PEABODY: So I mean --

VICE CHAIR KIRCHNER: Precisely. Are you going to put 20% in?

MR. PEABODY: The answer to that would be no. We would specify the limit in the tech spec. However, that limit would be less than 20% because there's a prohibition on going above 20%. I believe it's in 50.64. Yeah.

And again, too, like there's still going to be a limit that's explicitly specified in the tech

specs that that particular facility will not be able to go above without coming back with, again, a new criticality analysis that shows in advance that it's safe to go to a higher enrichment.

I'll also provide a quick comment on Walt's earlier question on the non-LWR. As part of the reg basis that we looked at, I know for my section and I believe for most of the other presenters, we did look at the 50 -- I'm sorry, the Part 53 separate rulemaking, which is in draft right now. I believe it's in the proposed rulemaking phases out, so it's still a draft guidance.

But what we're proposing here is consistent with what they're proposing there for nuclear criticality analysis.

VICE CHAIR KIRCHNER: The reason I brought it up is because the advanced reactors that come in are going to go through 50 and 52. They're not going -- 53 is not going to be ready. And they may not choose the 53 option, even if it were ready.

So when you're doing this, that was the purpose of my question. So that you don't, soon as you get one of those advanced reactors, you don't have to get into the exemption space again. Because several of them are going to look at going up to 20%.

Or just below.

MR. PEABODY: Yeah, that's true. And again, like the draft rulemaking for Part 53, which I acknowledge it may not be ready, but that's similarly -- it's basically it's similar to 50.68 in that it utilizes k-effective acceptance criteria, not active criticality monitoring like 70.24.

VICE CHAIR KIRCHNER: Good, thank you.

MEMBER MARCH-LEUBA: This is Jose. Just a clarification. I'm looking at 10 CFR 50.64. And it seems to apply only to non-power reactors. You guys can check that out, make sure that the 20% -- that's what I'm reading is (audio interference) for non-power reactors.

MR. BENAVIDES: Okay, but this is 50.68, so.

MR. PEABODY: Yeah, so --

MR. BENAVIDES: Sorry, sorry, part of -- Charlie.

MR. PEABODY: That's where they delineate the high-enriched uranium and low-enriched uranium threshold. I think there's also a -- I think they also define that in Part 2 of the definitions section. But again, I know -- I don't believe that any of the power reactors were applying enrichments nearly that

high when that was written.

But typically 20% is considered high-enriched uranium. We generally try to stay away from that in Part 50 or Part 52 applications as well.

MEMBER MARCH-LEUBA: My question is -- my comment is please review it, because it seems a naughty thought anybody would be crazy enough to do 22% enriched uranium on a power reactor. At least it may not be actually in anyone.

MR. PEABODY: Yeah, I mean, you would have to get the, I believe like the specific approval that that requires. But I'm not ready to talk about 50.64 today.

I'm not hearing any other questions, so I think I'll turn it over to the next presenter, which I think is back to you, Phil.

MR. BENAVIDES: Yeah, that's correct. Aaron, next, thank you.

Once again, Phil Benavides. As mentioned earlier, Don Palmrose is not available, so I'm going to present a few prepared remarks on his behalf. Slide 14, please.

(Audio interference) fuel cycle and transportation of fuel and waste are connected actions of the operation, nuclear power plants, under the

National Environmental Policy Act, or NEPA. Staff has previously performed generic analyses dating back to the 1970s to evaluate the environmental effects of the uranium fuel cycle in transportation of fuel and waste.

These evaluations are documented in WASH-1248 for the uranium fuel cycle, and WASH-1238 for transportation of fuel and waste, with the other supporting documents. This original analysis was for enrichment levels up to 4 weight percent U-235.

The uranium fuel cycle analysis was codified in the 10 CFR 51.51 as Table S-3 for the transportation of fuel and waste. The environmental effects were codified in the 10 CFR 51.52 as Table S-4.

Subsequent staff evaluations expanded Tables S-3 and S-4 for up to 5 weight percent U-235. Of note for Table S-4, there are other conditions that must also be met, else a full description and detailed analysis of the transportation impacts would need to be performed as part of the licensing action.

The staff has performed additional analyses to extend the enrichment levels above 5 weight percent. This has been done in two documents. The first is a study to support accident-tolerate fuel

deployment published in NUREG-2266, which the public comment period closed recently on October 31.

Additionally, the advanced nuclear reactor generic environmental impact statement that is before the Commission for approval also addresses the uranium fuel cycle for up to 20 weight percent U-235.

Until these documents have been finalized, the current practice for addressing these environmental impacts continues to be as, which is shown in the last two sub-bullets, where the uranium fuel cycle evaluations would be on a case-by-case basis, as has been done in prior new reactor applications.

And a full description and detailed analysis would need to be performed for transportation and fuel and waste. Next slide, please.

The staff considered three alternatives for both the 51.51 and Table S-3 and 51.52 and Table S-4. The first is the current situation, as mentioned in the previous slide, which addressed the environmental effects on a case-by-case basis.

Alternative 2 is the recommended alternative, which would incorporate the updated evaluations in NUREG-2256 and the advanced reactor GEIS into the regulation by this rulemaking to extend

Table S-3 and S-4 to the highest enrichment levels these analyses can support.

The third alternative would be not codify the updated evaluations but reference them for the environmental finding in individual license actions. Next slide.

That's the end of that presentation. If there's any questions, you know, unfortunately, Don's not here to provide additional insights, but we can take note and get back to you.

MEMBER HALNON: Yeah, this is Greg. Just when you said the highest enrichment that it could take. From the analysis, I'm assuming that's still going to be 20 percent is going to be the top amount. I mean --

MR. BENAVIDES: Correct, correct.

MEMBER HALNON: Okay, you're staying low.

MR. BENAVIDES: It's still low. I believe, you know, I would have to look into it. But I think maybe when they started, they may have been looking at maybe the current fleet and where they were going. Which maybe not the --

MEMBER HALNON: Okay.

MR. BENAVIDES: So.

With that, I guess we'll go on to the next

topic, which will be Jason Piotter.

MR. PIOTTER: Thank you, Phil. My name is Jason Piotter, I am a Senior Mechanical Engineer in the Division of Fuel Management. I am the lead for a ATF and advanced fuels in the Office of Nuclear Materials Safety and Safeguards.

Today I'm going to briefly discuss our consideration of the fissile material package requirements contained in 10 CFR 71.55. The regulations in 10 CFR Part 71 for package and transportation of radioactive material in general do not limit the enrichment level of the fissile material.

In one instance, 71.55(g), specific to UF6 packages, a provision is made that allows for an exception to the requirement to consider water and leakage, provided that the UF6 content is not enriched to greater than 5 weight percent U-235. And they've already advanced the slide for me, so thank you.

Absent utilizing the provisions in 10 CFR 71.55(g), applicants for a certificate of compliance have the option of evaluating these fissile material transportation packages, including UF6 packages, in a variety of ways.

One, they could use 71.55(b), including

consideration of water in-leakage, which for higher enrichments may require changes to current package designs or perhaps require new package designs to accommodate those enrichments.

An applicant could seek an exemption to 71.55(b) and the water in-leakage requirements. Or an applicant could seek an exception to the water in-leakage requirements of 71.55(b) using the provisions in 71.55(c). Next slide, please.

Based on its evaluation, the staff identified three alternative actions that the NRC could take. The first would be no rulemaking and utilize the existing certificate of compliance options I just mentioned.

The second option would be rulemaking to increase the enrichment limit up to 20 weight percent U-235. And the third option would be rulemaking to remove the enrichment limit altogether on this exception. Next slide, please.

The staff recommendation at this time is -- go ahead? Was there a question? Okay. The staff recommendation at this time is to take no action.

And that's primarily due to the fact that to date, the industry plans communicated to the NRC have not indicated that there would be enough requests

for package approvals for transporting UF6 enriched up to 20 weight percent to conclude that rulemaking would be the most efficient or effective process to support package approvals.

And I'll note that all alternatives at this point are cost-neutral in terms of implementation, but they vary based on where the burden of that cost would be born.

In light of the current recommendation of no rulemaking, the staff is seeking additional feedback, however, from stakeholders to determine if there's any additional information that can be shared to augment comments made by the public in June of 2022 regarding the need for rulemaking, which did not indicate a strong demand signal from industry for rulemaking for these UF6 packages. Next slide, please.

MEMBER HALNON: Jason, this is Greg Halnon.

MR. PIOTTER: Yes, sir.

MEMBER HALNON: Did you factor in this decision the aspect of regulatory certainty relative to this being the best alternative?

MR. PIOTTER: Yes, we did. And part of that consideration is also going to factor in the

responses that we get from the FRN question. And so we still have an opportunity after the public comment period to discuss that internally and sort of take a final action or make a final decision on that point.

But we wanted to also see if there was an additional demand signal coming from industry. So it is still on the table at this point, but again, if you're looking at the total demand signal that we expect to see and the fact that we've been able to issue CoCs for a UF6 package that's certified up to 20 weight percent.

It's already been demonstrated that the existing regulations are effective for being able to issue certificates of compliance.

MEMBER HALNON: Okay. Is there guidance out there for that, or are folks just using the precedent set by that approval you just mentioned?

MR. PIOTTER: There's not specific guidance at this point, I think primarily because the applicant in that case used the existing regulation in 71.55(b). So they considered water in-leakage for that particular package and had special design features to account for the fact that they had higher enrichment.

So we did not anticipate doing additional

guidance at this point for that because at the time, it was relatively straightforward with respect to the regulatory approach that they took.

MEMBER HALNON: Okay, so that would be an option if the demand goes up for such approvals, but at this point no need.

MR. PIOTTER: That's correct.

MEMBER HALNON: Thank you.

MR. PIOTTER: And -- go ahead.

MEMBER MARTIN: Oh, I was going to change -- if you wanted to complete a thought for Member Halnon's question, go ahead and finish it. Okay.

So I understand the logic behind what you -- your no-action recommendation. Kind of in the spirit of generically addressing things, it seems like it stands out, you know, oddly with everything else you're trying to do.

Here, the door is open. Why not just walk through it, you know, and spend the effort to just be consistent across the board with the overall effort.

If there was any question on guardrails, and again, I'm not, you know, familiar enough with 10 CFR 71, I mean, could a k-effective limit or something like that, like it's elsewhere, like in 68, could that kind of cover you for any concern?

Basically my question is why not just make it clean with the rest of the changes that are in -- that are all in the table maybe?

MEMBER MARTIN: No, and I appreciate that comment. And what I will say is we had received unofficial comments to that effect. That was essentially the one comment that we did receive that since we are going ahead with this rulemaking, why not just consider it here as well.

I think the difference here is that we have a very robust set of options within this particular regulation that offers industry a variety of ways to meet the regulation without necessarily having to focus on this very specific one for UF6 packages. Because keep in mind, obviously the 71.55(b) applies to all fissile material packages, not just UF6.

So in that instance, because it's narrowly focused and because there are additional options available, the assessment at the time was is that in this particular case, because of the other considerations with respect to cost and with respect to demand signal, it wouldn't be necessarily efficient or effective to move forward.

But certainly we have received that

comment and it has been taken into consideration in our deliberations.

MEMBER MARTIN: Thanks.

MR. PIOTTER: I would like to add just real quickly to two of the other questions that were asked earlier with respect, the first one with respect to experiments.

I will note that at least on the front end of the fuel cycle and the back end of the fuel, cycle, there is an active effort underway currently to do additional critical experiments, as well as to do benchmarking up to that 20 weight percent mark. And again, that's obviously to focus on the fact that we do not have that data available for those enrichment ranges.

The second item I just wanted to comment very quickly is with respect to are we considering advanced reactor fuels. And what I will say for with respect to NMSS, you know, we see those throughout the presentations that 20 weight percent is noted several times in the presentations.

I think when we got the SRM that came back down, that mention that we need to take into account the HALEU range, that automatically put us in that category of considering both ATF fuel and advanced

reactor fuels in our deliberations. At least that's very much true for the NMSS evaluation.

MEMBER MARTIN: I appreciate that comment.

MR. PIOTTER: And with that, Phil, I did not have anything else, so we could go to the next presentation if there are no further questions.

MR. BENAVIDES: Okay, the next presenter is Elijah Dickson presenting on control room design criteria.

MR. DICKSON: Thank you very much. My name is Elijah Dickson, I'm a Senior Reliability Risk Analyst in the Office of Nuclear Reactor Regulation, Division of Risk Assessment, Radiation Protection Consequence Branch. And I've been leading the ATF/source term work and coordinating work with the Office of Research now for a number of years on this.

So I can jump into my presentation, but before that, I can, based off my recollection of the public meeting last week, talk a little bit about some of the questions that we did have, if you like.

CHAIR REMPE: Please do.

MR. DICKSON: Okay, all right. So, and they're mostly clarifying questions. We have two questions for folks to respond to in the reg bases. The first one is in regards to how much information is

being requested. And I believe that was from industry in regards to the questions.

The first question was asking whether or not -- well, let's start with the second question, because that was the first question that was asked in the public meeting. I think one of the owners had asked a question in regards to instead of just having one single value as a control room design criteria, we are posing whether or not we should have a range of them, right.

And should we develop some type of risk-informed metric to have for the control room design criteria. The question was basically asking is that in fact what you're looking for.

So instead of just having one value, we'd have a range of safe values tethered to some type of risk measure. That was the first question, and that's effectively our response, is yes, that's effectively what we're looking for.

And then the second -- sorry. Then the first question was should the control room design criteria, that numerical value, be based off of normal operational exposure does limits of Part 20. Or should it be based off of emergency protective type dose recommendations? So that was the second -- that

was the second question.

And they wanted to know just how much information they needed to present to us in their response to that question.

Any questions about that? No.

And then I can talk a little bit about like the generic language as well that's discussed in Appendix A of the reg bases in regards to what we've been seeing as of late in license amendment space and in topical report space. And it ties into how licensees try to retain margin in these calculations and trying to meet that control room design criteria value.

And that we've been seeing with, especially with the vendors in developing topical reports, coming up with other types of methods and methodologies to do the dose analyses.

And so to try to keep consistency with the fleet, we felt that it would be appropriate to go, in the consequence analysis, you know, realm, instead of approving different topical reports and different license amendments, to retain this margin in their analyses that we'd go and do a thorough reassessment, I suppose, of the design criteria at this point.

Does that answer your question in regards

to like generically figuring, assessing this?

SPEAKER: I have a question.

MR. DICKSON: Yeah, okay, we can get into it, okay. All right, so I'll go ahead and start the formal part of the presentation. So the first part of the presentation is a summary of the regulatory issues.

General design criteria 19, the control room of Appendix A of 10 CFR Part 50, and 10 CFR 50.67(b) item 3, provide specific dose-based criteria in a 5 rem little effective dose equivalent for demonstrating the acceptability of the control room design.

The history of fuel utilization for the current large light water reactor fleet has seen a gradual progression towards higher fuel discharge burnups and increased enrichments. In general, there has been enough margin in the facilities design basis to accommodate the criterion even for power upgrades up to 120% of the originally licensed steady-state thermal power levels.

Increased power levels, enrichment, and subsequent fuel burnup have a multifaceted impact on the licensee's analysis of record computed design-basis accident radiological consequence analysis

results.

A rule of thumb is that an increase in power level has a linear effect on these results, an increase in enrichment necessary to reach the desired burnup levels increases the number of fissions in the reactor core in proportion increases these results.

The impact of higher burnup on radiological consequences is not -- on the radiological consequence results is non-linear for the abundance of different radionuclides peak at different burnup levels.

Therefore, depending on how the reactor core is designed with an increased enrichments and operated at higher burnup levels to reach longer cycle times, the impact on these radiological consequence analysis results computed to demonstrate compliance with the control room design criteria would increase and subsequently decrease the retained margin maintained by licensees to provide operational flexibility.

Now, the NRC recognizes the challenges licensees face in retaining this margin for operational flexibility purposes within their licensing basis in the small amount of margin through the control room design criteria itself.

The NRC does not want to unnecessarily penalize licensees in seeking increased enrichments that may then result in margin reductions and thereby require licensees to perform potentially extensive analyses to demonstrate compliance without a commensurate increase in safety. Slide 11.

MEMBER HALNON: This is Greg. The real challenge at the licensee level is that demonstration of compliance. If it's in analysis space, that's not, you know, it's pretty straightforward from analysis. It's when it gets into the physical testing of the control room envelopes and --.

Is there from a tech spec perspective, I mean, we all talk about there's so much leakage, in-leakage you can have into the control room envelope. And I've done those tests myself, and they're one, not repeatable. Two, you cross your fingers every time you start to test and hope that you can get there.

But typically what we've done is just do a complete physical examination of all the penetration and whatnot. Are we staying in analysis space in this rulemaking, or are we?

MR. DICKSON: We're staying in analysis space.

MEMBER HALNON: Okay, so we're not going

to require or ask for any other compliance demonstration from a physical perspective?

MR. DICKSON: No.

MEMBER HALNON: Other than making sure your design configuration is correct.

MR. DICKSON: That's correct. Yeah.

MEMBER HALNON: Thanks.

MEMBER MARTIN: And that was my kind of one question, just to clarify. So the slide or two coming up, it makes a comment about some new research, but it's pretty much all analytical that you --

MR. DICKSON: Yeah, it's all analytical.

MEMBER MARTIN: Okay.

MR. DICKSON: Those are in the alternatives, I believe.

MEMBER MARTIN: All right.

MR. DICKSON: So let's go on to slide 24, please. A little bit of background about the control room design criteria. GDC-19 and subsequently 10 CFR 50.67, B2, item 3, is one of 64 general design criteria provided in Appendix A of 10 CFR Part 50.

As stated in Appendix A, these general design criteria establish minimum necessary design fabrication construction testing and performance requirements for structure systems and components that

provide a reasonable assurance that the facility can be operated without undue risk to the health and safety of the public.

Although some design criteria may be reflected in the technical specifications, the GDCs in and of themselves are not operational limits. When put into practice, nuclear steam supply system engineers, architect engineers, utility engineers use these criteria and other regulatory requirements in establishing the design basis of the facility be constructed.

In evaluating the adequacy of the design, for instance for the control room habitability envelope, designers evaluate the control room by performing a series of deterministic design basis accident analyses.

During its review of the license application or the license amendment, the staff reviewed a design in the applicant's DBA analyses and performed subsequent confirmatory calculations as necessary and either accept or reject the application.

So with that, let's talk a little bit about the objective of the control room design criteria. The objective is to ensure that the design of the control room and its habitability systems

provide for a habitable environment for operators to remain in the control room and not evacuate during an emergency.

Ideally, you can think of this environment as short-sleeved environment comfortable for them to perform their safety functions under both normal and accident conditions.

A little bit of history behind the control room design criteria. It was really developed in the last 60s. Finalized in the GDCs in the early 70s, and then subsequently amended in the 1990s when the NRC finalized 10 CFR 50.67 for the alternative source term.

The criterion did not foresee how licensees currently operate their facilities and manager their fuel, consider fuel enrichments above 5 weight percent uranium-235, or maintain coherence with other regulations concerning the Commission's comprehensive radiation protection framework.

A little bit more about the intent of the control room design criteria. I have paraphrased from the statements of consideration for 50.67 that the control room design criteria does not imply that this would be an acceptable exposure during emergency conditions, or that the other radiation protection

standards of Part 20, including organ dose limits, may not apply.

This criterion is provided to assess the acceptability of the design provisions for protecting the control room operators under postulated design basis accident conditions. So I'd like to go onto slide 25.

MEMBER PETTI: A question.

MR. DICKSON: Yeah.

MEMBER PETTI: Part 20 does allow for higher doses?

MR. DICKSON: Yes, it does, and I'll talk about that. What I'm going to try and do in this, in I think in two slides, I added -- and I talk about the different slides that I added to this from the subcommittee meeting to try and like tie together this web of regulations for you to fully give you a full picture of how we're looking at this.

And the slide deck that I have here is a little different than what's there. So yes, background. So in this work, effective radiological risk communication is going to play a very important role in this rulemaking effort to describe the NRC's comprehensive radiation protection framework and how it works together to protect occupational workers.

Although the control room design criteria are distinct from operational limits, the NRC recognizes that the two concepts share some similarities. Specifically, both the operational occupational exposure limits of Part 20 and the control room design criteria are numerically equivalent and use the same units of rem TEDE.

Accordingly, the staff recognizes that there could be some potential for confusion should the NRC modify the control room design criteria to a higher but still safe performance level. Changes would not alter operational or emergency exposure limits controlled under Part 20, and subsequently 50.47, which are the emergency plans. Slide 26, please.

This is a new slide from -- that was developed since the subcommittee meeting. The standards for radiation protection are found in 10 CFR Part 20. They are based in part on the recommendations on the International Commission of Radiological Protection.

In 10 CFR Part 20, the NRC applies these standards to all exposure situations, both normal and emergency conditions, but also provides an explicit exemption in cases in which compliance would limit the

actions that may be necessary to provide health and safety.

To provide reasonable assurance that adequate protective measures can and would be taken in a radiological emergency, the NRC has established the emergency planning regulations in Appendix E of 10 CFT Part 50, as well as the emergency plans of 10 CFR 50.47. It's these emergency plans that provide additional regulatory provisions to bear on the control of occupational exposures during emergencies.

As paraphrased from 10 CFR 50.47(b)(11), the following is provided, Where there is the means of controlling radiological exposures should -- shall include exposure guidelines consistent with the EPA's Emergency Worker and Lifesaving Activity Protective Action Guidelines, or PAGs. These guidelines for actions to protect valued property is 10 rem, where lower dose is not practical.

The guidelines for actions for saving life or protecting large populations is 25 rem. These guidelines are endorsed, as I had mentioned, in 10 CFR 50.57, and is consistent the position in 20.1001(b).

MEMBER BALLINGER: This is Ron Ballinger. I have had drilled into me over the last 30 years the rule 5n-18 and 25.

MR. DICKSON: That's right. That's the old --

MEMBER BALLINGER: I thought it would be very easy to find the source of that. You've got the 25 in here, but for the life of me I can't, other than in a Navy manual, I can't find where the heck 5n-18 came from.

MR. DICKSON: That might be under the old ICRP 2.

MEMBER BALLINGER: Okay, I've got a bunch of ICRP documents.

MR. DICKSON: That's going back to like the 1950s, and --

MEMBER BALLINGER: Well, that's probably right, since that's when I learned it.

MR. DICKSON: Yeah. So we went through, you know, it wasn't great trouble, but -- we went through great trouble to understand like the genesis of these values and how they got in here, right. And for the control room design criteria, the rationale when they were doing that work in the early or late 60s, they codified the GDCs, it is kind of lost to time.

There is a bit of discussion in Appendix A on that topic. We pulled documents internally in

microfiche, ADAMS, legacy ADAMS. We were able to find some internal documentation as to why they selected Part 20 normal dose limits as the design criteria back then.

And the best that we could find was that there was only like a document changed based off of industry comments on those old GDCs that they said, you know, they wanted to pull out the design criteria itself. But when the final GDCs were put into place in GDC-19, the original GDC had a reference to Part 20, is what it had, is GDC-11 was the original GDCs that were proposed.

Then in GDC-19, the finalized one, they removed the reference to Part 20 occupational exposure limits and retained the numerical values. And then when they developed 50.67, we kept with that, we kept with that thinking, utilizing the numerical values that were in Part 20 as the design criteria for these emergency-type conditions.

So I tried my best to do the literature review in that area, and it wasn't terribly satisfying. But you know, a lot of the stuff was done back in the 50s.

MEMBER BALLINGER: Thank you.

CHAIR REMPE: We have a question from a

consultant, Stephen Schultz.

Steve, do you want to unmute yourself and ask it?

MR. SCHULTZ: Yes, I just wanted a clarification first. The last bullet that you have here is that guidelines for action is ten rem, and my question is simply the guidelines you're referring to here is 10 CFR Part 20. Is that where that is coming from?

MR. DICKSON: No, that's coming from the EPA's PAG guidelines.

MR. SCHULTZ: Okay, and just a comment as well. When I went through the appendix associated with the regulatory rulemaking basis and so forth, and in the basis itself, I really didn't find a detailed description of what this background is and where you're going with it.

What I did find in the references was the NRC's report in June this year on increased enrichment rulemaking -- on the control room design criteria and radiological health effects. That was as a reference, and as I looked at that, I found information that really supports this approach, this evaluation and the presentation you're making today. I think more information ought to go in the main document as you go

forward with your recommendations.

MR. DICKSON: Understood, and we can do that. That was a research request that we made to the Office of Research to assess the control room design criteria in the context of, I think, current health physics, radiation protection standards, understand what's out there, understand what the research is, understand what's being recommended by bodies such as the ICRP, the NCRP, the EPA, and give us a jumpstart into how we're going about moving forward in this area, and we can pull some of that information into the regulatory basis too.

MR. SCHULTZ: It's a very well-prepared report that provides elements of justification of why this approach may be suitable going forward.

MR. DICKSON: Right.

MR. SCHULTZ: Thank you.

MR. DICKSON: Yeah, thank you. Well, thank you for that.

MEMBER ROBERTS: Elijah, if I can -- this is Tom Roberts. If I can repeat back what I think you just said on the last two slides, and then I'll have a question at the end of it?

MR. DICKSON: Yes.

MEMBER ROBERTS: I want to make sure I got

it right, that the previous slide talked about a figure of merit, that the five rem, ten rem, whatever the requirement is really has no physical meaning. It's a figure of merit. It's as this is a prescription that's been agreed upon in the past. If you calculate that your control room dose is below this number, you're good.

And what good means is not entirely clear to me, but you're good, which leads to the next part of this, which is once you get into the reactor accident space, you have emergency guidelines imposed, which is you take whatever you, basically, to some degree, whatever you need to take given certain guardrails that are put into place, or you ask for volunteers when you get beyond those guardrails, but if you have to take actions to save the reactor or, you know, help the public, or whatever the objective is, you're going to find a way to take it. Do I have that right so far?

MR. DICKSON: That's right. That's right.

MEMBER ROBERTS: So, what I'm still not completely seeing is a connection between those two, because we talked yesterday in the level three PRA discussion about how they've started to do a level two HRA, and part of the level two HRA is an evaluation of

control room doses during accident scenarios.

And we didn't get a whole lot of detail of what came out of the studies, but it's a relatively new technique they're using to try to gain a better understanding of the risk associated with, you know, getting into the level two, level three reactor damage state. And that seems to have a connection to what you're doing here and I'm still not completely seeing that connection --

MR. DICKSON: Okay.

MEMBER ROBERTS: -- that if you increase the allowable figure of merit for, you know, your control room dose, and presumably the TSB is part of this, then you're also increasing what that dose is going to be in the emergency situation, and then it becomes more and more difficult for the operators to take those actions, and it seems that you would understand that, and maybe that's part of the risk information you were talking about with the public meetings you have --

MR. DICKSON: Yeah.

MEMBER ROBERTS: -- earlier, but it seems like that whole story ought to be better understood.

MR. DICKSON: It's a complicated story, and what I failed to do during the subcommittee

meeting, you know, I really stressed on, and I did in this last paragraph or last slide too, about how the framework of radiation protection works and how it is cohesive, but what I did not provide was the guidelines and procedures that operators are trained to during accident conditions.

So, that's like when they have to exercise the EOPs, the emergency operating procedures, when they go in and they have to start exercising their SAMGs, and the flex, as well as the extensive EDMGs, extensive mitigation via damage guidelines that were developed after post-9/11, and so I failed in that area. And I did develop a slide to help talk about that.

So, having discussions in regards to how Part 20 controls occupational exposures during an actual event was done well, but we need to strengthen discussions in regards to what operators are actually doing during an event, and I do have a slide in here that kind of talks about that. At one point, it was slide 47, and if we need to, we can jump to that in the questions' section.

VICE CHAIR KIRCHNER: Can you go back one slide? Because your lead in to this -- or it might be another one further back then. Yeah, this is it,

yeah. What I noticed is I would almost bold the word emergency, the third line. I mean, the way I'm thinking about it is that an emergency is when you actually have the accident.

MR. DICKSON: Yeah.

VICE CHAIR KIRCHNER: That's not normal operation. Whether it's a DBA or a beyond DBA, it doesn't matter, and for normal operation, the figure of merit should be way below five rem, I mean, because that wouldn't meet ALARA in my mind.

MEMBER HALNON: This is exactly why I asked the question earlier about staying in analytical space versus physical. Every emergency plan I've been associated with would not allow somebody to get 25 rem in a control room. You start developing shifts in dose --

MR. DICKSON: Right.

MEMBER HALNON: -- goals as soon as you get out of the area of trying to address the exact accident. So, these are analytical figures of merit, but it's not reality from the standpoint of what physically is going on in running your procedures, and developing shift coverages, and that sort of thing.

So, it gives you a design criteria. You meet the design criteria, but your emergency plans and

your actual physical aspects limit doses far below these types of things. So, you can't sit there and think oh, I'm going to let my operator get 25 rem. That's not going to happen.

MEMBER ROBERTS: Right, where I think analysis and reality meet is that if you design, you know, have early systems, it will allow double the dose, and you're going to double the challenge to the operators who have to go stick to those procedures.

MEMBER HALNON: You'll double the challenge of getting operators --

MEMBER ROBERTS: Right, it might be --

(Simultaneous speaking.)

MEMBER HALNON: -- to minimize their dose. You might have to have three shifts instead of two.

MEMBER ROBERTS: Right.

MEMBER HALNON: You know, but you're not going to continue to dose out your operators --

MEMBER ROBERTS: Right.

MEMBER HALNON: -- because you need them.

MEMBER ROBERTS: And you're also not going to give up.

MEMBER HALNON: Right.

MEMBER ROBERTS: So, it's --

MEMBER HALNON: So, there's other goals

going on, including ALARA, that --

MEMBER ROBERTS: Right, the first time I asked is trying to understand what challenge the, you know, going to a higher control room deterministic figure of merit, you know, dose level, would impose in emergency plan space, emergency preparation space. And there is a footnote in the appendix that says that there is no risk information to be gained, and it seemed like from yesterday's meeting, there is risk information to be gained.

MR. DICKSON: Yes, and --

MEMBER ROBERTS: Maybe that could be beefed up in the report.

MR. DICKSON: Yeah, and again, the slide that I provide at the very end of this talks a little bit about that. I won't be as sharp presenting this slide. I just developed it two days ago in thinking about how I could talk about this.

You know, I'd like to add that the calculations that are done to demonstrate compliance, they don't really consider operator actions. You know, they assume a full core melt with that source term, but then design, you know, the leak rates for containment and the leak rates, and assess the leak rates out of valves and things of that nature.

And the individual is a reference individual. It's just a person standing in that control room during a certain amount of time. We also don't model the administration of prophylactics, right. So, KI is a very important prophylactic that any radiation protection manager would probably be administering to their operators and their staff to protect against thyroid dose. Those types of things are not modeled in these calculations.

And you think of it as well as this is kind of like a defense in depth or margin to safety between the current five rem and that upper bound EPA 25 rem value, right. So, right now, we have it at five, the occupational exposure limit, or at least referenced as it, and then you have this upper bound of 25 rem, so we're trying to come up with something in between. Okay, with that, I'll --

MR. SCHULTZ: This is Steve Schultz.

MR. DICKSON: Yeah.

MR. SCHULTZ: Just a reminder that with regard to what we're generally speaking about here is the control room limitations and design limitations associated with the design basis accidents --

MR. DICKSON: Yeah.

MR. SCHULTZ: -- versus severe accidents.

MR. DICKSON: Right.

MR. SCHULTZ: And so, the analysis we're talking about that is done in the design process associated with core reloads and so forth is the evaluation for design basis accidents versus severe accidents.

MR. DICKSON: Thank you. With that, I'll go onto the next slide, slide 25, 27.

MEMBER ROBERTS: Just following up on what Steve just said, it's not really even a design basis accident, right? I think it truly is a figure of merit because the scenario is not a consistent scenario.

MR. DICKSON: Well --

MEMBER ROBERTS: There is probably no real scenario that would lead to the five rem you calculate in the control room.

MR. DICKSON: They are stylized calculations, and the one that really matters is the MHA LOCA source term where we use the MELCOR calculations and come up with a full core melt source term, and we use that to establish siting criteria as well as for just control room design criteria as well.

MEMBER ROBERTS: Right, so Steve, tell me if I've got this wrong, but I think the real key is

that there is this transition from analytical space to operational space, as Greg well pointed out, that there's a figure of merit that said this is good enough, but it's kind of hard to put any physical meaning on it.

If you don't meet good enough, then it's a little worse than good enough, and I don't think we're going to have a good insight on where we've crossed that cliff. There probably is no cliff because at some point it becomes much, much harder to manage the accident, and again, that's where the risk information may come in --

MR. DICKSON: Understood.

MEMBER ROBERTS: -- useful to understand what does it really mean, because I don't think we know right now what it really means other than for 50 years, we've used it as a guideline.

MR. DICKSON: Okay, so now I'll talk about, if we're ready to move on, I'll talk about the alternatives. The staff considered three alternatives in this area. The first alternative is to take no action.

We would maintain the current regulatory framework. We would continue to revise existing guidance with updated source terms when data become

available, as well as update transport models on an ad hoc basis as research and resources become available. We would plan to issue this work in Reg Guide 1.183, Rev 2, in fiscal year 2025. Next slide, please?

Alternative two is to pursue rulemaking to amend the control room design criteria and update the current regulatory guidance accordingly with revised assumptions and models, and continue to maintain appropriate and prudent safety margin. The staff has already assessed and identified a range of acceptable values based on sound regulatory and scientific recommendations.

We would be initiating new research and analyses for the development of mechanistic transport models and re-baseline several other important operational and human health assumptions. We would plan to issue this work in Rev 2 of Reg Guide 1.183 in support of the control room, the amended control room design criteria.

Alternative three, you can think of this as our most research intensive alternative where we would not be pursuing any rulemaking, but we would be updating the current regulatory guidance with revised assumptions and models, and continue to maintain appropriate and prudent safety margin.

We would be, like in alternative two, initiating new research and analyses for the development of mechanistic transport models, and re-baseline several other operational and human health assumptions, and assess other mathematical methods, computational, and statistical approaches to reduce the unnecessary conservatisms and provide greater flexibility. We would plan to commence this work on Reg Guide 1.183, Rev 3 based on this new research analyses soon after Reg Guide 1.183, Rev 2 has been issued. Onto the next slide, please?

Our recommended option is alternative two, an amended control room design criteria and revision to the applicable regulatory guidance considering risk information would be the most cost beneficial, straightforward, durable, and efficient path for licensing increased enrichments up to 20 percent of radium-235.

The beneficial impacts on other regulations such as 50.59 and Part 20 would also be realized. It would be flexible enough to consider multiple approaches, and amending the regulation would provide an option for a generic resolution of these issues. We would be inviting stakeholder input and participation in this decision affecting this

regulatory area rather than on a case by case basis that would result in the current regulatory framework.

Staff would be able to utilize ample operating experience, scientific data, technical information, and numerous recommendations from national and international organizations responsible for radiation protection standards and regulatory precedents that supports the reevaluation of the control room design criteria.

In general, there is a range of regulatory base and stakeholder base recommendations for radiation exposures to workers under normal and emergency conditions, and these range from ten rem to 25 rem or 50 rad whole-body.

As such, the control room design criteria intended to assess the acceptability of a given control room design is on the lower side of this range of recommended values for emergency response planning purposes and protect against actual incurred radiation exposures.

And that's it with my presentation today. If we had additional questions, or I could go down to one of the back-up slides that talks about more of the like guidance and procedures that are in place that operators are trained to, to respond to varying

degrees of accident conditions.

MEMBER HALNON: Elijah, from a process perspective, Rev 2 says fiscal year 25 or --

MR. DICKSON: Yeah.

MEMBER HALNON: -- a month into fiscal year 24. It seems like a lot of work to get done and get approvals, and public comments, and everything else done.

MR. DICKSON: It is.

MEMBER HALNON: Do you think it's doable? I mean --

MR. DICKSON: I do. Rev 1 really laid the groundwork in regards to how we want to approach developing Rev 2. We are considering and looking at the work that's already been done by Sandia in performing additional analyses of their 2023 source term report. We're looking at a lot of experience in regards to the last 22 or 23 years of licensing 50.57 in the AST. There's -- we're ready to incorporate this type of information.

MEMBER HALNON: When we reviewed Rev 1 of 1.183 --

MR. DICKSON: Right.

MEMBER HALNON: -- we encouraged, obviously, to not delay Rev 2 --

MR. DICKSON: Yeah.

MEMBER HALNON: -- because it took so long to get Rev 1 out. So, again, I think we would encourage the same thing in this situation, obviously, to make sure we meet that due date that we have for the reg guide.

MR. DICKSON: Putting Rev 2 under the umbrella of the increased enrichment rulemaking will provide more resources --

MEMBER HALNON: Okay.

MR. DICKSON: -- to help move that forward.

MEMBER HALNON: Okay, I was thinking it would bog it down, but I'm glad you're optimistic.

MR. DICKSON: Yeah.

VICE CHAIR KIRCHNER: Elijah, are you thinking, not to put you on the spot, but are you thinking -- you know, you provided an additional slide this morning to your slide deck that kind of summarizes perhaps, or that provides the basis -- have you taken a stab at writing this down, what this would look like?

MR. DICKSON: I have.

VICE CHAIR KIRCHNER: Yeah.

MR. DICKSON: So, it's slide 46.

MEMBER PETTI: We only have 44 slides.

MR. DICKSON: Oh.

PARTICIPANT: I'm sorry, the backups.

PARTICIPANT: It's a new backup?

MEMBER PETTI: Oh, you got them, great.

MR. DICKSON: Oh, okay.

MEMBER BALLINGER: We need to have the backup slides as part of the record.

MR. DICKSON: Okay, so here's the backup slide, and this is a simplified framework for emergency response procedures and guidelines that operators, licensees follow in regards to responding to a range of accidents. The phrases and the words in here are generic.

It can be different between PWRs and BWRs, you know, specific to specific licensees, but I developed this following some of the work that we'd done in updating the severe accident guidelines for BWRs and the severe accident management guidelines for PWRs post-Fukushima, so some of that is all kind of revised.

So, here is my written thoughts so far is that following the subcommittee meeting, I found myself thinking about the proposed control room design criteria in 10 CFR 50.67 as it relates to severe

accidents that are beyond the design basis for safety-related SSCs for operating reactors.

I found that I focused too much on the framework of regulations of protecting against ionizing radiation from Part 20 and Part 50.47, and I didn't adequately cover the framework for how each licensee addresses an integrated use of emergency response procedures and guidelines in such a way that they work together to implement the best available strategy for preventing or mitigating fuel damage and limiting radiological released in beyond design basis accidents. It's clear to me now that we need to have further discussions in this and maybe include this type of information in the regulatory bases documents, so I do want to state my apologies in this.

So, what I found is I developed this illustration to show how the conservative nature of our regulations and the integration with other regulations, along with the traditional design basis accident analyses with their included defense in depth and additional safety margin, help address operators in successfully responding to a spectrum of accident conditions.

This figure illustrates the framework of how each licensee addresses this integrated use of

emergency response procedures and guidelines in such a way that they work together to implement the best available strategy for mitigating radiological consequences or preventing fuel melt.

The left side of this slide presents the various procedures and guidelines that have been developed. They are stacked in order of severity from the bottom to the top, normal operating procedures up to severe accident management guidelines.

The right side of the figure presents how these procedures are implemented during various plant states. We give a little bit of a definition between procedures and guidelines. Procedures are documents written as sequential instructions to perform a function or address plant conditions where operators and plant staff are expected to follow prescribed instructions in a step by step, verbatim manner.

Guidelines, on the other hand, are not necessarily provided as prescribed sets of instructions and may not be followed in a step by step manner. Rather, they provide suggested strategies and implementation methods that may be used to address adverse conditions or events, typically those beyond the design basis of the facility.

Now, there's been some discussions and

questions in regards to the assessment of operator performance under accident conditions. This does, it does fall in a different regulatory area under 10 CFR Part 55 for reactor license, you know, operator training, senior reactor operator training, requalification programs.

That stuff is done, but in a different regulatory area that's outside of assessing the design of the control room itself, and these are done for, you know, the alarm response procedures or AOPs. These are done for the EOPs. And then subsequently, there is also the severe accident management guidelines too. So, that's what I have here. Any questions on this?

MEMBER HALNON: Yeah, I would add one aspect if you can consider it, and that's the emergency action levels that drive the TSC.

MR. DICKSON: EALs?

MEMBER HALNON: Yes, I mean, that clearly, in the accident management regime, plus maybe a little bit to the left of that line, take hold, and you can take credit for the TSC and EOF staffs under 50.47. I know you tried to separate that out, but that -- it is essential in developing the severe accident management strategies --

MR. DICKSON: Understood.

MEMBER HALNON: -- and even the, or most of the EOPs. Many EOPs will get you into, if you got into the EOP, you probably got at least an alert or --

MR. DICKSON: Right, okay, yes, thank you. I'll take any more comments on this and --

MEMBER PETTI: I like that. I like his comment. I think there's going to be very effective communication --

MR. DICKSON: Okay.

MEMBER PETTI: -- to the side.

MEMBER BALLINGER: For a metallurgist, this is very --

(Laughter.)

MR. DICKSON: Okay.

MEMBER HALNON: You don't hear that very often from metallurgists.

MR. DICKSON: Got it. I'm working on it now. There's -- you know, all of these different procedures, and guidelines, and strategies have been developed over a period of 60 years or so. They all have different regulatory hooks to them or not.

They all have different regulatory requirements in regards to the training, and getting it all down in one document, you know, in a distilled

format is something that we're looking into now based off of our conversations that we've had here at the ACRS, so thank you.

MR. SCHULTZ: Elijah, this is Steve Schultz. I think you're moving in the right direction with providing some very -- this is a super communication tool, and it's also a good structure that can be used to move forward with the goals of this portion of the rulemaking.

One more comment associated with the document itself, there seems to be a concern about moving forward with the control room design requirement that is higher than five rem TEDE, and would that be difficult in communication to the organizations associated with the overall operational dose limits of five rem, moving away from that?

I really think that that's not a concern, and that given tools like this, you can communicate very clearly that there is a reasonable, a real reason for the difference, and you really go down two pathways to establish both of those requirements, and it should be very clear to both the public as well as the operational staff as to why the criteria are different.

MR. DICKSON: Understood. Yeah, effective

radiological risk communication is clearly going to play a very important role in this rulemaking effort and making sure people understand what it is that we're trying to accomplish here, so we'll continue on with that and keep working on sharpening our message, looking into areas that need to be looked in further. We'll keep doing that. Do you have any questions? No? Okay, all right, thank you. With that --

MEMBER BALLINGER: I'm about to make a suggestion, Madam Chairman, that we take a break.

CHAIR REMPE: Okay, I'll honor your suggestion. It's about 10:00 here, so why don't we come back at 10:15?

MEMBER BALLINGER: Thank you.

CHAIR REMPE: So, we'll recess.

(Whereupon, the above-entitled matter went off the record at 9:59 a.m. and resumed at 10:15 a.m.)

CHAIR REMPE: Okay, it's 10:15 and we're back in session, and I'll turn it back to you and then you can pass it onto the staff.

MEMBER BALLINGER: Now, what did Bette Davis say? Buckle up, it's going to be a bumpy ride. Anyway --

CHAIR REMPE: That must have been before my time when she said that.

(Laughter.)

MEMBER BALLINGER: He remembers. Okay, let's proceed.

(Laughter.)

MS. SMITH: This is Ashley Smith. Joe Messina and I are co-leads for the fuel dispersal portion of the meeting. I'm going to be going through the first few slides and then I'll hand it off to Joe. Next slide?

First, I'm going to discuss what FFRD is and then I'll discuss its history. High burnup experiments have shown that fuel can fragment during a loss of coolant accident. Differences in pressure across the cladding can lead to ballooning and burst of the cladding. The fragmented fuel can relocate into the balloon region. If burst occurs, the fragments can disperse into the reactor coolant system.

The first image here is of FFRD testing that was done at Argonne National Lab. It shows fuel fragmentation occurring. The second image is a pictorial representation showing that once the fuel fragments, the fragmented pieces relocated into other areas of the fuel such as the balloon region. The third image shows results from the LOCA test at the

Studsvik test facility, and as you can see, the burst openings can be large enough for the fuel to disperse into the reactor coolant system. Next slide?

This slide has a timeline of the history of FFRD. To start, the 50.46 acceptance criteria for LOCAs were created in 1974 when FFRD were not known phenomena. In 1980, FFRD was discovered during experiments at several test facilities, indicating that irradiated fuel could fragment into small pieces during a LOCA and may relocate axially, settling into the balloon regions.

In 1984, NRC puts FFRD into the generic issue program as GI-92, but later concluded that known conservatisms would offset increased heat generation resulting from fuel relocation. It was dropped from the GI program in 1995. In 2006, tests at Argonne National Lab and Halden indicated that fragmentation and relocation could result in a loss of fuel particles through the ruptured opening.

In 2008, RIL-0801 was issued discussing recent high burnup research findings and nothing that additional research on fuel dispersal was being conducted, but stated that the current 62 gigawatt days burnup limit is probably low enough to prevent significant dispersal.

In 2012, NUREG-2121 was issued discussing the knowledge base of FFRD at the time. In 2015, SECY-15-0148 was issued stating that 50.46(c) should not be delayed to include FFRD, but that research will continue to be conducted and future rulemaking may be initiated if necessary. Basically, it was believed that there is no imminent safety concern from FFRD up to 62 gigawatt days per MTU.

In 2016, the draft final rule for 50.46(c) went out. In 2021, RIL-2021-13 was issued documenting the Office of Research's interpretation of FFRD experimental research to date. In the RIL, the staff defines conservative boundaries for FFRD-related phenomena such as the amount of finely fragmented fuel expected to be dispersed during a LOCA.

In 2022, SRM-SECY-21-0109 was issued by the Commission directing the staff to address FFRD in the IE rulemaking regulatory basis. In 2024, there will be a PIRT conducted on fuel dispersal to help identify further research needs, potentially develop guidance, and to help focus NRC staff reviews of applications that may evaluate FFRD.

MEMBER MARTIN: Question. This is Member Martin. I appreciate this timeline. It's always nice to see a background kind of distilled into a single

slide. A couple of things that I thought might have been missing from this, first, since you threw the PIRT on there, a couple of my colleagues back in the day participated in 2001 in a LOCA PIRT with high burnup fuel.

I notice that wasn't mentioned in any regulatory basis, you know, sections in your report. I do think that was worthwhile. At least, my colleagues that I worked with once upon a time thought, you know, their time was well spent. It does address, you know, fuel dispersal. It basically concluded that it was really a coolability question. It kind of discounted the others.

So, one of the questions, at least regarding to the PIRT is, or the new PIRT is what new do you expect there? Would it really be a revision to that old -- and its NUREG, I wrote it down, NUREG-CR-6744. Would it be a replacement? Are you going -- you know, addressing it maybe at a different scale of phenomena? What's new?

MS. SMITH: I'm going to turn it over to Joey or possible James. I know James is on the line. Research is conducting the PIRT. Do you want to clarify that?

MR. CORSON: Sure, yeah, this is James

Corson. I'm from the Office of Research at NRC. So, basically, you know, we're certainly aware of that earlier PIRT. This is considering even higher burnup.

So, I think back in 2000, 2001, it was based on fuel up to 62 gigawatt days per MTU. There's been, you know, a lot of research since then on even higher burnup fuel and additional tests at Studsvik and Halden with new data that we think is applicable.

And as you say, you know, coolability is really the big concern, and so we're going to be focusing on that particularly, you know, different phenomena that can affect coolability of dispersed fuel. I hope that answers your question.

MEMBER MARTIN: Sure, sure, of course, on that, you know, looking at higher burnup, of course, that's the goal. Tests at Halden, of course, went up as much as what, over 90 gigawatt days per metric ton? No one's talking about burning that far.

I will look around to see if I'm wrong about that, but they're looking at what, you know, near term, maybe 68, 75 kind of thing, and this, you know, kind of puts some guardrails on any, on the work given that the demand appears to be limited to 75. I can -- I feel like anything beyond 75 might be a distraction, right?

I mean, we know it gets worse and becomes more and more like sand as you get up, and then, of course, there's a particular test at Halden where it was at 92 and, of course, it cited in numerous locations that, you know, it definitely dispersed and was a mess, but I think, well, it's not applicable, you know, I mean, at least as far as what people are asking for. Would you put guardrails on that PIRT to limit it to, you know, something a bit more consistent with the marketplace?

MR. CORSON: Sure, yeah, so one minor clarifying point. So, you know, people are thinking about going up to maybe 75 gigawatt days per MTU peak rod average burnup, so you could have, you know, pellet average burnups that are quite a bit higher, maybe ten percent higher.

Of course, it depends on your operating history. So, really, we are talking about you could have portions of the fuel rod that are in the low 80s gigawatt days per MTU.

So, as you point out, you know, the Halden tests do go up even higher and things get worse and worse as you get higher, so that is going to be considered, but I think there aren't that many tests that are above where we're going to go, I think maybe

two or three Halden tests. I'd have to go back and look at the exact number.

MEMBER MARTIN: Okay.

MR. CORSON: But your point is well taken that certainly things get a lot worse when you go up that high.

MEMBER MARTIN: And maybe a little bit to the point, of course, you have the NUREG-2121 that was published in 2012. I noticed that OECD, which, of course, NRC participated in, of course, an extensive program, actually published a, I would say, a fairly informative and useful research report in 2016.

You know, it gets into some, you know, quite a bit of detail. It wasn't cited in your regulatory basis document. I thought maybe you might want to add it to the story just so, you know, people that look at this can appreciate this is not just the U.S. looking at this.

You know, it's an international program, and I think that report kind of gets into the level of detail at least some stakeholders would be interested in, so I'd just recommend that maybe you incorporate that into, you know, the final version of that document for public comment.

MR. MESSINA: That's a good comment.

Thank you. We can definitely add those to create a more comprehensive picture.

MR. CORSON: And this is James again. Just to put you at ease, we are considering that report as part of the PIRT. So, yeah, we should have included mention of it in the regulatory basis, but, you know, we're certainly aware of it, and at least as part of the PIRT, it's part of our package of materials.

MS. SMITH: All right, thank you. Are there any more questions or comments on this slide?

VICE CHAIR KIRCHNER: What's your -- this is Walt Kirchner. What's your objective for completing the PIRT in terms of timeline?

MS. SMITH: The timeline for completing the PIRT? Is that the question?

VICE CHAIR KIRCHNER: Yes.

MS. SMITH: I can touch base on that, and James, you can correct me if I'm wrong, but they're currently working with a contractor to organize the PIRT later this year, and then the completion of the PIRT report will be in early 2024.

VICE CHAIR KIRCHNER: Thank you.

MEMBER BALLINGER: So, by those words, the PIRT report will be out in plenty of time for the

rulemaking, which is due to be the end of 2024, December 2024. So, the results of that PIRT could affect the rulemaking effort itself, information which we don't have now.

MS. SMITH: That's correct.

MEMBER BALLINGER: Thank you.

MS. SMITH: Okay, next slide? This slide discusses the background and regulatory issue of fuel dispersal. As stated in the timeline on the previous slide, the 50.46 acceptance criteria date back to 1974 when FFRD were not known phenomena.

Acceptable approaches to demonstrate compliance with the regulations have ensured that catastrophic failure of the rod structure and loss fuel bundle configuration are precluded. Fuel dispersal would be a departure from precedent because the fuel bundle geometry would be lost. Fuel dispersal is not explicitly addressed within the current regulations. Next slide?

MEMBER MARTIN: Question. This is Member Martin again. So, in a previous life, I did LOCA analysis for money, and realistic LOCA analysis, and we would track, you know, various representative rods. One of them would, of course, be a high burnup rod, and, of course, we would have, I don't know, maybe you

want a first cycle rod.

Just about every time, it's going to be a first cycle rod or an early second cycle rod that is limiting, you know, as far as your peak clad temperature is concerned or a rupture potential. That high burnup rod just was pretty boring. It wasn't getting the power.

You know, it -- and we had a NUREG-630 model in there and so, you know, whatever, it's an old model, but the reg needs to be updated on new research or design specific modeling, you know, that could otherwise make it more realistic.

But, you know, when you think about rulemaking and 50.46, you know, certainly the coolability question is out there, but when you think about other alternatives to putting your guardrails on high burnup, one, you can do a lot of analytical research. I think it will vet out my point.

Now, granted, you know, can you dream up of a scenario where you have higher power and somehow a late, you know, high burnup rod becomes limiting? Well, you pile on certain conservatisms or, you know, you have a lack of information even in a realistic model, maybe it's possible.

All of that's kind of to lead up to the

thought, well, it can get complicated, and what I haven't heard or seen is any mention of, say, like Reg Guide 1.157, which is the best estimate LOCA reg guide. It hasn't been touched since its inception. You know, for people that developed methods, it was kind of the Bible.

As a matter of fact, I'm sure, I know fuel fabrication and relocation is mentioned in there. I'm not sure about anything about dispersal in any kind of context, but possibly. Why not focus on a revision to the reg guide and maybe allow some latitude for the applicant to, you know, beat this to death with analysis under, of course, a review topical in that sense in the spirit of, say, what's being done with Reg Guide 1.183, right?

MR. MESSINA: Yeah, I can take this. This is Joe Messina. So, we are actually separate from the increased enrichment rulemaking effort, and our efforts here, we are in the process of updating Reg Guide 1.157 to be more modern. And so, you know, can they analyze it to death?

That's certainly a possibility, and that would be more in line with alternative three presented in the reg basis, but obviously, there are a lot of challenges and it would take a lot of research in

order to be able to model, you know, once the fuel gets out of the rod, if this phenomena adds play to it, you know, a 95/95 as all other LOCA phenomena are modeled.

MEMBER MARTIN: And I agree, if the fuel got out. My point was that it wasn't -- you know, we were not seeing it get -- you know, we weren't seeing ruptures.

Now, granted, it's been a long time. It's been 15 years since I've played in that world. Who knows that, you know, plants are pushing, but maybe one of your stakeholders -- once you get out to public comment, you might find something along those lines.

MR. MESSINA: Yeah, and as we go to higher burnups, you know, some of the higher burnup rods end up at little higher power than they used to be at, so that combined with, you know, the increased fission gas release, we do see a lot of high burnup rods burst.

And our Office of Research did a study on quantifying the number of rods that burst and the amount of fuel that would be dispersed from these rods. Actually, they published a paper in August in NURETH, yeah.

MEMBER MARTIN: Okay, yeah, I wasn't so

sure about power, but pressure is definitely higher.

(Simultaneous speaking.)

MR. MESSINA: Yeah, we have that paper.

PARTICIPANT: We have that paper.

MEMBER MARTIN: Okay.

MS. SMITH: Okay, are there any other questions or comments before I move to the next slide?

CHAIR REMPE: You mentioned that this rulemaking is separate from the increased enrichment rulemaking. Doesn't it seem like there should be some sort of coordination?

MR. MESSINA: Well, this rulemaking -- the fuel fragmentation and relocation and dispersal, the rulemaking for this is part of the increased enrichment rulemaking. I was talking the update to Reg Guide 1.157 is --

CHAIR REMPE: Okay, I would have thought this would be tied. I thought you just indicated that there was a rulemaking that was separate for the increased enrichment, and I thought this was one of those.

MR. MESSINA: No, no.

CHAIR REMPE: Yeah.

MR. MESSINA: This is part of it.

(Simultaneous speaking.)

MEMBER BALLINGER: This is Ron Ballinger. What's the schedule for that update?

MR. MESSINA: I don't know at the moment. John, do you --

MR. LEHNING: This is John Lehning from Nuclear Methods and Fuel Analysis Branch. So, right now where that is, there's a report that a contractor has prepared to help us sort of collate a lot of the research since 1988 or '89, and so we're in the stage of reviewing that draft, and so I assume it might be, let's say, over a year, maybe two years into the future before we'd be ready to publish that updated regulatory guide based on the review of this research.

It is a lot of work that's been done in the last 30 or so odd years, and so I think some of the coordination might come in depending on which of these options gets recommended and ends up going forward. As you know, we haven't made our recommendation yet, but that could be a part of, for example, alternative three, let's say. It could bring this into a little bit tighter coupling.

MEMBER BALLINGER: But the rulemaking schedule, such as it is, is December 2024, and what you're saying is that update is quite a bit beyond that.

MR. LEHNING: At the present time, that's the way it is, although things, as you know, could change, and we did talk about some of the impacts to the rulemaking schedule depending on bringing this issue, and that wasn't part of the original plan, and those have yet to be fully scoped out in terms of how that might affect things, but, yeah, your understanding is correct at this time, that that's what I have at this time.

MEMBER BALLINGER: Thank you.

MEMBER MARTIN: Member Martin. Just a real quick comment. I just, I know that it's part of our practice. I definitely want to see that revision. We recently had a draft guide that did not -- it bypassed us before it went to public comment. I definitely want to see that.

MR. MESSINA: Sounds good.

MS. SMITH: Okay, next slide? The staff have developed five alternative licensing pathways that could be pursued. The five alternatives are considered mutually inclusive where combinations of elements from multiple alternatives could be considered.

The staff is also open to considering other approaches not included in the five alternatives

based on public comments. Joe is going to talk about the specifics of each alternative. Next slide?

MR. MESSINA: Yes, good morning, Jos Messina again, Nuclear Methods and Fuel Analysis Branch. I'm going to go into some details on each of the alternatives outlined in the regulatory basis for fuel dispersal.

To start off, I'll begin with the status quo and consider maintaining it as one of the licensing pathways. In this alternative, we would keep the current regulatory framework mostly the same without any major updates, and continue with the precedent that a significant amount of fuel dispersal should not occur.

Therefore, the most straightforward licensing approach under this pathway would be to demonstrate that rods susceptible to fine fragmentation do not burst and thus lead to significant dispersal.

It is expected that technical solutions would need to be developed to prevent high burnup rods from bursting, such as changes in fuel design and/or core design, and well possibly the use of ATF could also help. For example, coating may limit the balloon size and the burst opening size, but that has not been

quantified yet.

I'll note that since the regulations do not explicitly speak to fuel dispersal, allowing significant dispersal may not technically require a change to the regulatory framework, but this would lead to a lot of regulatory uncertainty and challenges by both industry and the NRC. Therefore, pathways that consider significant dispersal are discussed as part of other alternatives. Next slide, please?

The second licensing pathway proposed rethinks a 50.46(a) style modification of ECCS requirements. For those that are not familiar with 50.46(a), it was a final rule that went to the Commission in 2010 and it risk informed LOCAs.

Specifically, it established a transition break size. For breaks smaller than the transition break size, LOCAs would be analyzed as they are today, but for breaks larger than the transition break size, less conservative assumptions and modeling could be employed, such as allowing for credit of offsite power.

In this licensing pathway, LOCAs above the transitioning break size would essentially be treated as beyond design basis. In beyond design basis accident analysis, best estimate modeling and more

realistic assumptions can be employed, while during typical design basis accident analysis, a 95/95 is the typical standard for modeling.

The use of beyond design basis modeling may help to show that no rods susceptible to fine fragmentation end up bursting as a result of a LOCA, but it still may be challenging. Therefore, this pathway could be combined with other pathways that analyze the consequences of fuel dispersal. There would also be an obvious benefit outside of FFRD in the LOCA analysis with this approach such as increased margin to the PCT and oxidation limits.

I'll note that this would likely not be a simple cut and paste from the 2010 rule. This would be a modernization of the rule. We can update it with any knowledge gained since 2010 or update it to better capture today's landscape. Part of the work that would need to be done would be to reassess the NUREG-1829 and NUREG-1903 LOCA frequencies.

MEMBER PETTI: Joe, just a question. So, I assume there were statements of consideration that were behind this change in the rule, in this, you know, in 50.46(a), even though it never got -- this never got implemented, right?

MR. MESSINA: Correct.

MEMBER PETTI: But did you go as far as to have those things in consideration --

MR. MESSINA: Yeah, we looked at the FRN and all of the relevant documents that went to the Commission.

MEMBER PETTI: Sure, this, in my mind, you're moving away from 50 years of precedent with this rule, so this is a biggie in my opinion, at least in the draft letter that I -- I didn't put to Ron. This is one of the key points.

So, it would be interesting, I think, to pull that up. At least I think it would help us as we think about it, but I just wanted to make sure I understood because this is before my time on the ACRS. Thanks.

MR. MESSINA: Yeah, there aren't many people at the NRC people left from that effort.

MEMBER PETTI: Elijah had to dig deep.

(Laughter.)

MEMBER ROBERTS: I was wondering if you have any, you know, insights on the word may you've underlined there, like has there been a sample calculation done or some sort of, you know, an estimate based on other work, that, you know, you think of as may?

MR. MESSINA: So, the reason I underlined may is because under this alternative, we proposed keeping, maintaining the precedent that significant fuel dispersal should not occur, and using best estimate modeling may not be able to show that all rods do not, all high burnup rods do not burst, and this is --

We included the may due to the calculations in the NURETH paper from August, which showed, yeah, I think it was about 75 percent of the core burst. I mean, not all of those would be high burnup, but a still significant amount of high burnup rods would burst.

MEMBER ROBERTS: So, it's likely not?

MEMBER BROWN: Uninitiate Charlie Brown, uninitiated person in the detail that you all work with. Is this a result of now going to the higher enrichment and it wasn't a problem when you start and you keep yourself below five percent, a wider dispersal or a wider range of burst fuel rods?

MR. MESSINA: So, yes, the amount of dispersal would increase as we go to higher burnups and, you know, there's more fragmentation of the rods, so more of the fuel pellet is susceptible to dispersal. And as we go to higher burnups, more high

burnup rods end up off of the periphery of the core, so it would be at higher powers and possibly more likely to burst.

MEMBER BROWN: So, we're now going to be willing to accept a worse result by going to this than we have -- am I reading this correct?

MEMBER PETTI: No.

MEMBER BROWN: I'm not an expert on this.

MEMBER PETTI: No, no, Charlie, I think -- I mean, the calculations that were done suggest that you may not be able to demonstrate, you know, with a sharper pencil.

MEMBER BROWN: What we used to demonstrate.

MEMBER PETTI: Right, when you move to the higher burnup.

MEMBER BROWN: To the higher burnup.

MEMBER PETTI: But, that said, the calculation has -- there's a lot of assumptions around that calculation. The fission gas release which is driving the burst behavior has got a lot of uncertainty on it. How you calculate the stress on the clad and the burst, there's multiple models that show different behavior. So, you move deeper into analysis hell is what --

MEMBER BROWN: Without experimental verification?

MEMBER PETTI: There is -- some of the old models have experimental verification. Some of the new ones, let's call them fundamental, less empirical, it's kind of a mix. So, all of this stuff has to be kind of figured out, right, and that's why I describe it as -- it's not a slam dunk.

More calculations have to be done, you know, I think, with more sensitivities to really kind of understand better. I mean, just to do what they did was a pretty big calculation, so, and then to take the next step to sensitivity, it's just, it's a time, you know, thing to get it all.

MEMBER BALLINGER: The limit that the RIL suggests is 55, above 55, plus other criteria, you get dispersal.

MEMBER BROWN: Above 55 gigawatt days, I think I remember hearing 60 in a lot of our previous meetings.

MEMBER PETTI: So, there is this inconsistency that one of the documents said it's not a problem below 62, but then the RIL sort of says there is a problem that you could interpret between 55 and 62. But there's some nuance in there that I think

has to be applied.

MEMBER BALLINGER: But you have to have first.

MEMBER BROWN: I understand that, but fundamentally it means you get more dispersal of obviously fuel throughout the reactor coolant system, and every place else, it's just not a good idea in general. And we don't have any real test data that we --

MEMBER PETTI: No, there's a bunch of data, we reviewed it in the RIL, and there's issues there, you can go back and read our letter. We weren't convinced that all the experiments are prototypic enough that you may not be getting some false negatives.

MEMBER BROWN: I didn't remember that part.

MEMBER PETTI: Yeah, Ron and I worked on that one.

MEMBER BROWN: Yeah, that's not exactly in my radar.

MEMBER PETTI: So, again, you'll see, I mean these are all the things you've got to consider as part of the option space, which this is multi-dimensional, it's not easy. So, this discussion I'm

sure will happen again later.

MEMBER MARTIN: I wanted to clarify one of the statements, of course it's your statement, but the best estimate modeling comment, you made a note of course, you can apply more realistic assumptions. Every fuel vendor has a LOCA best estimate methodology that already looks at 95/95, and that was mentioned. When you get into severe accident space and that's redefining the break size to redefine basically what a design basis accident is, or what the severe accident is with regard to LOCA.

Typically you're looking more as a 50/50, more of a median. Now, you do that, and that's a huge margin. Typically the margin is just staying with best estimate. Well, with a statistical approach, are like as much as 200 F for standard deviation, so you could have 2 sigma 400, 500, that kind of range. So, yeah, 50/50 would be tremendous.

If these designs already comply with the 95/95, your temperatures would be solo particularly for a realistic high burn up rod. I'm sure it would show no rupture.

MR. MESSINA: Yeah, the worry for the high burn up rods really isn't related to PCT or oxidation. It's more, now that it's fuel dispersal, so for the

most part we worry about PCT and oxidation for, as you said, the lower power rods at the high power -- the lower burn up rods at the high power. And then now that we introduced this problem basically of fuel dispersal at high burn up.

Obviously if fuel disperses, can that fuel end up heating both sides of the rod, and lead to higher PCTs? That's obviously could be something that could occur. But we're looking into that more in the purview.

MEMBER MARTIN: Right. And I can't help it, passion here, when we stylize these LOCA analyses, we impose a peaking, and typically it's not realistic peaking. Those are peakings that may be you have a hypothetical xenon transient or something like that, and it pushes the power up or down. Usually we pick an up, because from a thermal hydraulic standpoint.

But you don't burn in fission products really. So, when it comes to shutting down, you're on decay heat, everybody, as far as I know, is biasing their post SCRAM power with an assumption that you burn in your fission products, and have decay heat that is affecting, and that has a huge effect on your temperatures.

And no one has probably bothered to think

about making a more sophisticated decay heat model, but that might be one of the things. It's a huge concern, particularly when you're in this space where you're talking about what might break, and spill out. You took that out, that might eliminate it too. But something to kind of put on your radar. We have very simple decay heat model, and if you put some realism in there, again, that might go away.

So, if you're doing a little bit of analysis, the codes would all need to be modified to do that. But I think you'd also find that temperatures come way down.

MR. MESSINA: Yeah, thank you. If there's no other questions on this slide, next slide please? So, the third licensing pathway proposed in the regulatory basis is to provide a safety demonstration of post fuel dispersal consequences. I alluded to this a little bit before this alternative. And so, phenomena such as core coolability, recriticality, and long term cooling would need to be addressed, just as any other LOCA phenomena, which is to say modeled at 95/95 probability and confidence.

As a part of this, guidance would be developed regarding the analysis of the consequences. We are sponsoring the PERT that was mentioned before,

and this would help us to issue guidance with the rule if we go ahead with this alternative. This guidance though, would have to be relatively high level, and conservative though, since there has not been a ton of experimental research on the consequences of fuel dispersal conducted to date.

But we envision that the PERT would inform future experimental research that can be conducted in parallel, and in subsequent years, and this research could be used to update the initial guidance that goes out with the rule to be more specific and less conservative.

VICE CHAIR KIRCHNER: Joe, you mentioned 95/95, my reaction to that is I don't even know where to start to frame my comments, it makes no sense. We don't have that kind of modeling capability once we get beyond the intact geometry and start dispersing things. I mean 95/95 is good for CHF correlations and so on, but to think you're going to get 95/95 on a stochastic process like this, I mean you don't even know where the ballooning is going to take place.

You're just going to assume in your analysis a threshold, that's where you will calculate ballooning. In reality that's not the way ballooning happens. There's so many variables that we can't

model that well, that if you go down this route, you're going down the route that the LMFPR people were going down, and 95/95 just doesn't make any sense to me at all.

You're in a different space completely than the traditional LOCA analysis with an intact geometry. So, I'm just reacting to the 95/95. We can model this, we've got things like MELCOR, but to think you're getting 95/95, it's a highly non-linear problem.

MEMBER MARCH-LEUBA: I will concentrate not on 95/95, but on the calculation, and I'll be happy to do a 50/50, the best testing. Which you probably can't.

VICE CHAIR KIRCHNER: It's extremely non-linear space once you get to this --

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: The only way this can be conceived is by Appendix --

(Simultaneous speaking.)

VICE CHAIR KIRCHNER: This is stochastic --

MEMBER BALLINGER: This is a nightmare. The old PNNL, they did a whole bunch of burst tests back when you and I were much younger, and they tried

to analyze the results, and they simply threw up their hands and said we can't figure anything out. And they spent a lot of money on those burst tests.

MEMBER PETTI: Well, you remember the old code FRAPT.

MEMBER BALLINGER: Yeah.

MEMBER PETTI: I mean we've been calculating this stuff, well, trying to calculate it forever. I agree, it's not -- I'd call it analysis hell.

MEMBER BALLINGER: It's an exercise in hallucination.

VICE CHAIR KIRCHNER: It'd be one thing to say best estimate, but 95/95 is an expectation now that's just not credible. And I came out of this world with TRAC, so hating myself.

MR. SCHULTZ: Joe, this is Steve Schultz. This is an area where I would have underlined and bolded may impact increased schedule.

MEMBER BALLINGER: Steve was around when they did those burst tests.

VICE CHAIR KIRCHNER: That's one member's comment, Joe.

MR. MESSINA: Thank you, appreciate that. Next slide please. So, the fourth licensing pathway

would be to provide a generic bounding assessment of dose, and use risk insights to address post fuel dispersal consequences. Currently there are dose criteria for most DBAs, but for a 50.46 LOCA that is mitigated, we assume the consequences are bounded by the MHA LOCA dose.

Or the maximum hypothetical loss of coolant accident dose, which assumes an unmitigated LOCA that leads to a substantial melt of the core, which is talked about in Reg Guide 1.183. This option though, would establish a dose criterion for the LOCA analyzed under 50.46 with fuel dispersal.

Licensees would need to demonstrate the ability to predict the source term for LOCA with fuel dispersal, or be directed to use some fraction of the MHA LOCA source term based on the amount of fuel that is predicted to be dispersed. Regarding the other consequences of fuel dispersal, in this option we postulate risk insights could be used to address them.

For example, insights from operating experience, and other regulatory requirements, and industry initiatives may be able to be used, such as the severe accident mitigation guidelines, TMI action plan requirements, et cetera. That's all I have on this slide.

MEMBER BROWN: If you have widespread bursting, which you've referred to in your comments, how does this affect your ability to shut down the reactor? Is there the possibility of not being able to shut it down, and thus have control room issues, and thus have to have alternative systems? I'm trying to get a grip on how massive this fuel dispersal is, and what its impact is on the ability to even shut it down.

Because this is a LOCA, can you get them in in time, do you have the sensors, the data to be able to get the rods in before you have a more widespread disruption of the fuel elements and ruptures? I haven't heard anything in the discussions on the ability to shutdown, other than were it a LOCA, we normally assume we can shutdown when we've got a LOCA.

Or at least that's been my past experience at my old jobs, and what I've heard up until then. And I haven't heard anything at all about on any problems with shutting down the reactor under these circumstances, which would seem to me, comes into play somehow.

MR. MESSINA: Yeah, and the consequences as I said before, the consequences of what happens,

and what are the effects and impacts once the fuel leaves the rod, we're still looking into them.

MEMBER MARCH-LEUBA: With respect to shutdown in LOCA, you use SCRAM within the first second, and then LOCA --

(Simultaneous speaking.)

MEMBER BROWN: I would like to think, I mean I agree with --

MEMBER PETTI: It just takes a little longer to get there.

MEMBER MARCH-LEUBA: Yeah, on the LOCA consequences of decay heat generated, the control rods will need half an hour.

MEMBER BROWN: So, based on your opinion, in my old job I would have assumed the same thing also, a very quick response, because we can do that, but I'm not -- but this is a different configuration that I'm used to, so that's why I'm asking the question.

MEMBER MARCH-LEUBA: With respect to criticality, the designers make a big effort to put their U235 in the most favorable condition for criticality.

(Simultaneous speaking.)

MEMBER MARCH-LEUBA: You do this first, it

goes in a favorable geometry, so I wouldn't worry about criticality if the rods went in, you have a LOCA and an ANWAS (phonetic), which is a completely different thing, but we typically analyze it.

MR. MESSINA: Okay, next slide please. So, the fifth licensing pathway presented in the reg basis is to use probabilistic fracture mechanics to show that leaks in large pipes will be identified before failure, precluding the need to analyze ECCS performance during large break LOCAs. This would be a major departure from current practice, and would have implications outside of LOCA space as well.

This licensing approach builds on industry initiatives, such as EPRI's alternative licensing strategy that was presented to ACRS a few months back. This licensing pathway would use XLPR, or the extremely low probability of rupture code, and the leak before break, or LBB concept to show that leaks in large pipes would be able to be detected, and operator action would be able to be taken to shut down the reactor with sufficient probability before a pipe breaks and the large break LOCA occurs.

If the large break LOCA does not occur, this would prevent any fuel rod failures, and thus, fuel dispersal. This alternative also states that if

it can be shown that the large break LOCA does not occur with these methods, then ECCS performance would not need to be analyzed for the large break LOCA.

MEMBER MARCH-LEUBA: So, as a licensee, I find alternative five very appealing, and you can -- I mean you know, that's what they want to do. So, what is the staff doing to prepare for that review? You are not going to recommend one, two, three, four, or five. But we should anticipate licensee is going to want to push towards five.

MR. MESSINA: Yes, and we make our own decision based on stakeholder feedback, considering safety, defense in depth, and maintaining all of those. So, just because industry wants something does not mean we will bend over.

MEMBER MARCH-LEUBA: In the near medium time future, you are going to get a lot of submittal, a lot of requests to tell me that XLPR can calculate these things with sufficient accuracy and robustness to be able to accept it. So, the staff needs to be preparing for that.

MR. MESSINA: Yes.

MEMBER BALLINGER: Again, it's my understanding that this is actually happening. That

EPRI, there's a submittal that will occur in the first quarter that does this. So, that's still the case?

MR. MESSINA: As I know, yes.

VICE CHAIR KIRCHNER: Joe, can you distinguish this one from number two, the transition break size? I mean basically when you go into analysis of this, you would probably look at a break size that you could withstand without FFRD in alternative five. I presume that same surge is going to happen in alternative two. So, is there a definition for transition break size?

MR. MESSINA: So, transition break size as proposed in 2010, in the initial 50.40 CFR rule, we do anticipate that the transition break size would have to be established for alternative five, and that those were based on LOCA break frequencies in the two NUREGs that I previously mentioned. And for PWRs in 2010, it was the largest attached pipe to the main coolant piping, which is the pressurizer surge line with an inside diameter of about 11 to 12 inches.

For BWRs, it was the largest attached feed water, or residual heat removal line inside containment, which has a diameter of around 22 to 24 inches, and these were derived to match a break frequency of one to the negative fifth per year.

VICE CHAIR KIRCHNER: So, I'm thinking in terms of regulatory certainty, and such on one hand five would be generic if I could use that word, go figure out and demonstrate to us what that break size is. Two would really codify the existing fleet, and our knowledge of how the NSSS systems work for the existing fleet, and the database that supports that, which would be the same database for number five, to demonstrate your probabilistic fracture mechanics.

The code is basically sound, would it help if between two and five, is there any advantages? They both would have to do the same analysis in the end to demonstrate to you, the regulator, that they've avoided significant rupture and dispersal.

MR. MESSINA: So, no, alternative five is kind of drastic in that after the transition break size is established, above that we don't look at ECCS performance.

MEMBER MARCH-LEUBA: So, you basically remove LOCA from chapter 15 analysis?

MR. MESSINA: Correct.

VICE CHAIR KIRCHNER: Or LOCA --

(Simultaneous speaking.)

MR. MESSINA: Large break, yeah.

MEMBER MARCH-LEUBA: With two you still

have a LOCA analysis from the last break size, but used a different, more relaxed methodology.

VICE CHAIR KIRCHNER: So, you could potentially not do a LOCA analysis under five?

MR. MESSINA: A large break, you'd still have to address below the transition break size of a small break.

MEMBER PETTI: It's defined as outside the design basis, right? In option five.

VICE CHAIR KIRCHNER: So, what size LOCA would you have that demonstrate? Because let's be realistic, pipes fail, systems, so at some point, one would expect that you prudently in defense in depth, you would allow for a certain break, and then demonstrate that your ECCS systems -- I mean taken to its extreme, you said it's not probable that we have a large break. Then you can take away the ECCS systems, and it doesn't sound like a good step.

MEMBER BROWN: That would be next on the request line.

VICE CHAIR KIRCHNER: I said that rhetorically, I didn't mean that. But you take it logically, there's no logically, there's no large break LOCA, we don't need accumulators on a PWR as an example.

MR. MESSINA: Yeah, so the way I think we should look at the options are it's a sample space of options, and we try and consider the bounds of that sample space, and will consider within the sample space as well. So, these are bounds, we'll consider them, but we'll also consider within the bounds.

MEMBER MARTIN: One thing you have to consider when you're talking about break size, if you took large break LOCAs kind of off the table, or into a different space, if there was margin, what are the fuel vendors, the plants going to do, right? Now, likely they're non-LOCA limited, frankly, but if they weren't, they're going to crank up those power plants, and then all of a sudden --

MEMBER PETTI: That's the interesting question, right? If this goes away, what limits a PWI?

MEMBER MARTIN: Right.

MEMBER PETTI: Probably ENB one of them, and how big the steam generators are because you can't increase indefinitely, but it's an interesting question.

MEMBER MARTIN: I think there are already plants that are non-LOCA limited because of progress with best estimate LOCAs. But nonetheless,

hypothetically, if there was more margin because of this being removed, and there was room with small break, they would definitely crank up the power, and then you might find -- I mean small breaks, you can have pretty hot small breaks.

Now, I don't think everybody, when I say everybody, the fuel vendors and plants are necessarily on best estimate small breaks, obviously Westinghouse, I'm not sure where other vendors are with small break. And I assume you're still saying -- I mean Appendix K, if you're still on Appendix K, small break method, it's really off the table, right?

I mean once upon a time 50 years ago, kind of the feeling was the conservatisms in Appendix K were such that you covered the unknown unknowns, and this of course would have been in that category back then. I thought I saw that actually in the regulatory basis document, that opinion. So, taking Appendix K off the table, you could find small break case that got up there.

I still think it probably wouldn't affect a late burn rod, but nonetheless, if the door is open, people are going to walk through that door too. So, keep in mind, the final point there is I'm not so sure a transition break really matters. LOCAs will be

there regardless.

MEMBER BROWN: Sometimes to excess.

MR. MESSINA: Next slide please. So, we provided five licensing pathways in the regulatory basis, but at the time we do not provide a recommended pathway because we feel that stakeholder feedback is important before making such a decision. We provided six questions to the public in the FRN, and the reg basis on fuel dispersal alternatives to better help us make a decision.

And as we previously stated, these alternatives are not mutually exclusive. We will consider combinations of the alternatives presented, or any other proposed pathways that may not have been discussed. Overall, as I said, I like to think of it as a sample space of options. We provided some boundaries for the sample space, we're considering those boundaries, as well as options within the boundaries, and may consider options outside of the boundaries.

Maybe there's a brilliant idea that we didn't think of, and we didn't propose in the reg basis, but we'll see based on public feedback.

MEMBER BROWN: Why do you use the term stakeholder perspectives? I mean that's like an

opinion, they'd like to have this, or they'd like to have that. Why shouldn't they, if they want one of these, why shouldn't they provide some technical basis for why one of these is acceptable, even though you have questions relative to the alternatives you've developed?

Isn't it upon them to demonstrate the satisfactory application of even what was alternative five, where you have no restraints at all, which from what I hear from the other discussion, and not being an expert on this, although having some background on it, is you were saying that's what you're kind of expecting them to go to. I heard that in a couple of comments during your all's discussion.

So, I don't understand the thought process perspective. If I was a regulator like you all are, I would expect the industry to tell you why is this okay in my plant. Why do you have to justify the alternative without them providing the analysis, and basis, and substantial reasons why these alternatives will not be an additional risk to the public? That I don't understand, why you have to justify them doing it, as opposed to them showing you why it's okay.

MEMBER BALLINGER: Charlie, that's what ALS is, option five. And there's a submittal that's

going to happen, and we're anticipating getting EPRI in here, or whoever does it, to give a more detailed presentation. We did have a presentation from EPRI as one of the four things we have, and they mentioned ALS. But it wasn't a presentation on ALS.

MEMBER BROWN: ALS is alphabet soup for me, say the ALS again?

MEMBER BALLINGER: Alternative licensing strategy.

MEMBER BROWN: Okay, thank you.

MEMBER HALNON: In all this though, the regulatory tools to get answers, you just don't have enough information to put a generic safety issue, or a 50.54F letter, I mean there's just not enough to force the licensees right now to spend a lot of money on analysis without having a back fit, or some other issue that you have to deal with in regulatory space. So, there's a lot of questions, but there's not a regulatory tool other than the FRN that you have out right now to gather information to see if there really is a generic safety issue.

I mean, our biggest relocation event in TMI showed that criticality wasn't a problem, coolability wasn't a problem, dose wasn't a problem to the workers, we've got all this stuff, now granted,

that was brand new fuel, and obviously a serious event, and you don't want that to happen. But until you get to enough answers to say I can issue a generic letter, or you can issue a 50.54F, you can't force the licensees to do anything based on, in my mind, based on just what we have so far, which is I think I might have an issue. But they should --

MEMBER BROWN: Well, but why isn't the licensee, I mean this is to their benefit if they can operate at higher power enrichments, and therefore whatever your magic 62 goes to 85 or whatever the number might be. It seems to me if that's in the benefit, I mean in my old world if I wanted to do something different, I had to demonstrate why, now I would propose to the rest of my world why this is okay and why we think it's satisfactory to go forward without any.

I didn't wait for them to tell me what I needed to do, I had our program, at least that's what I remember.

MEMBER HALNON: Right, but that's why alternative five is not being --

MEMBER BROWN: I've been out of it for a while, so I don't think they've deviated that much.

MEMBER HALNON: That's why alternative five right now says may impact increased rule making for enrichment is not one of them on the table right now. So, you don't want to really increase the schedule for enrichment, right? I mean, this is out there, but it's not necessarily a direct road block to the higher enrichment at this point.

MEMBER BROWN: Well, are they just -- with 62 I thought they were looking at, maybe I lost it somewhere along the line with all the numbers. 62, they want to go something higher than 62, where you are today, is that what they want to do?

MR. MESSINA: Yes, the industry would like to go above 62 gigawatt days rod average.

MEMBER BROWN: To where potentially? What's in sight, not aspirational, but what would be reasonable in sight?

MR. MESSINA: I've heard 68, and up to 75.

MEMBER BROWN: Fairly substantial change, 20 percent in one case.

CHAIR REMPE: We have a --

MR. BLEY: This is Dennis Bley, and the staff can correct this if I say it wrong, but I believe there's a congressional mandate to help the industry in this way, is that so? At least that's the

way I read some of the last couple of laws that affect us.

MR. MESSINA: Yeah, NEIMA, the Nuclear Energy Innovation and Modernization Act, I believe addresses that.

MEMBER BROWN: Okay, but does that -- you all don't go out and do it, you don't run experiments at any of the facilities, I mean that's -- you're a regulator that evaluates the plants, and what they do, and what they can do, and what their limits are. It's not a matter of you developing an entire regime of operating space for people to be able to go into. DOE may have that responsibility if they even recognize it.

CHAIR REMPE: At the beginning of the regulatory basis, correct me if I'm wrong, but you raised this document, it talks about yeah, we can let them come in one by one with exceptions, or we can try and be proactive, and initiate rule making to be more efficient as a regulator. And all the staff is doing in this document, for various regulatory requirements that they've identified, or recommending where they can, options.

And in this last case, there's a lot of options they haven't decided yet, and they're trying

to do this. So, the research to support what they ultimately come in is way down the pipe is my opinion, and you can correct me on this. But I'm also a little concerned about time, and so that's why I'm kind of trying to answer this in a way --

MEMBER BROWN: You're trying to tell me not to ask any more questions.

CHAIR REMPE: No, I would never do -- well, maybe I would do that, Charlie, but I'm trying to give an answer to try and take my perception of that, is that a sufficient answer to the question? So we can get to the last slide?

MR. BENAVIDES: Yeah, this is Phil Benavides, what we're doing here is we're trying to create a regulatory framework that allows the licensees to go ahead and submit license amendment requests if they're making modifications at their facilities.

MEMBER BROWN: My only point being is that -- let me, understand, I will try to restrain myself. No, I won't. But I have no problem with doing what you're doing, that's not it. But developing a basis for why that is okay, seems to me that has to be with the people that want to do it. You say there's some options we can consider. You have to tell us how we

can justify that from a regulatory basis, and accept that as a basis for going forward.

And I haven't heard, you're just throwing perspectives, well we'd like to do that. It just seems to me a more direct way of phrasing this would have been a little bit, I didn't quite get that. I understand where you're all going, I understand you're trying to set a framework where they can consider alternatives, but you're not the developer of the basis for why they can go do that.

You don't develop the tests, you don't have test reactors, you're not getting it, there is no data all to --

CHAIR REMPE: Charlie, the basis is for rule making, not anything else, right?

MEMBER BROWN: But if you set the rule out there, and it's higher, then they --

CHAIR REMPE: They have to submit it to the commission to go forward with the rule making, okay? Am I saying that correctly, folks?

MEMBER BROWN: It just means the okay on it.

MR. MESSINA: Yes, the commission has to approve.

MEMBER BROWN: I understand that, I do

understand that. All right.

MEMBER BALLINGER: And by the way, it's the commission that specified FFRD had to be included by the way. It was not in the original SRM.

MEMBER BROWN: Well, I mean -- I could make some comments about that, but I won't, not in this forum anyway. All right, I'll quit, I'm sorry. My job is to be inquisitive, even if I make (audio interference).

MR. MESSINA: Next slide please. So, I just put all the alternatives on one slide if it helped with seeing it as any discussion comes up. But that concludes my presentation. So, if there are any additional questions?

MR. SCHULTZ: Joe, was there any specific questions in this area at the public meeting last week? This is Steve Schultz.

MR. MESSINA: Yeah, Steve, good point, sorry, I meant to mention the public meeting. There were a few questions, not very technical detailed, but two of the questions that I'll highlight were from NEI. One was how are we using the NURETH paper in this regulatory -- in this process. And the other was more wise, answering the how can they answer the questions, and how should they answer the FRN

questions, and provide their perspectives as well as answers to the questions.

MEMBER BALLINGER: Let me try and restate the time line that we're dealing with here. We have this document which we're considering, we have obviously the FFRD is hanging out there. We have a PERT that's going to occur sometime, I have it early 2024. We have the EPRI submittal, which is supposedly in the first quarter of 2024. And then the draft rule would have to be ready before December 2024.

And Lord willing, if the creek don't rise, Reg Guide 1.157 might get out there in draft form, the modification. Am I getting it about right? Is there something else in the time line that influences what we're doing here that we need to think about?

MR. MESSINA: I believe --

MEMBER BALLINGER: The PERT, and the submittal, that adds information, which is important for this.

MR. MESSINA: Yeah, I believe those are the main things that we expect in this process. And all of the slides say as we get the public feedback, and assess the options more, we'll figure out any impacts to the schedule from the FFRDL terms.

MEMBER BALLINGER: Okay. Public comment?

Okay, so we thank you very much.

MR. MESSINA: Thank you.

MEMBER BALLINGER: Now it's time to go out for public comments. If there are members of the public either out there or in the room that would like to make a comment, I don't know whether he disappeared or not. He's there. Let's try the outside ones first. Are there members online that would like to make a comment? Please state your name, and make your comment. Are we online?

CHAIR REMPE: We are. If you're on a phone line sometimes you have to hit star six to unmute yourself, but the rest of the folks on computers can just unmute their mic, but I'm not seeing anybody wanting to do anything.

MEMBER BALLINGER: Okay, now with that being the case, we have in the room, does anybody -- there are more than one.

(Simultaneous speaking.)

MEMBER BALLINGER: And speak loud.

MEMBER BROWN: Tell him to move closer.

MEMBER BALLINGER: No he's fine.

MR. PARILLO: This is John Parillo, I work with Elijah in the Radiation Protection and Consequence Branch. I have had some long concerns

with design basis in those criteria, which I submitted a PRM about, it's PRM 50-129. But what I would like to request that the committee, in contemplating any change to the control room criteria, consider the change in relationship to the offsite criteria.

There's a disparity not only in the number in that criteria, but also in the verbiage. For instance the offsite criteria was always presented not as an acceptable dose to the public, but rather as what they called a reference to the evaluation of accidents at very low probability. So, basically that was what Elijah's referring to as a figure of merit.

However, the GDC19 has now been incorporated into 50.67 it starts out saying adequate radiation protection is provided by limiting the dose to five rem. So, there's a disparity not only in the numbers, the values, but in the concept behind them. And I would encourage you to consider having a basis that apply to both of those values. In my PRM I suggest it as a voluntary rule, use of a health physics basis of ten rem.

But that's not really what I want you to consider. What I want you to consider is looking at these values, the control room, and off flow with the same level of consistency. Because right now, I think

we're -- at least I'm very hard pressed to find any consistency in our current regulations. So, thank you very much.

MEMBER BALLINGER: Thank you. Al?

MR. CSONTOS: Al Csontos, NEI, director of fuels. And so, we were one of the ones that asked for the extension. This is a very complicated rule making. A lot of good questions that the NRC has asked of the industry. We have a lot to discuss, a lot of stakeholders wanting to discuss the various aspects, as well as not only the legacy reactors, but also maybe advanced reactors as well.

And so, this is a very complicated rule making. And a lot of the questions that you're asking here, a lot of questions we're asking internally. We're also going to specifically focus on timing. We have strategic aspirations to move to two year fuel cycles, as well as possibly power up rates, as you were hearing earlier today. And so, the questions though that are on the table for us is not just these questions, but also when can we implement?

And what's reasonable to do in a time period to implement achievable things, all of these options. And so, as Joy was mentioning, we asked the question of how can we provide a more holistic

consideration of these options? And so, that was one of the questions that the staff answered during the public meeting last week. And so, just want to mention that I think we heard some of the same comments both at the subcommittee, and full committee.

And actually, you're asking the same questions that we are as well. But you're going to hear from us, hopefully we can get the extension, you'll hear from us, I think a path that is timely to what I think the commission wanted, as well as the industry wanted to meet their aspirations. So, I think just more on that later, but at this time just want to give that feedback to you that this is complicated.

And I guess don't assume that all the options that are being thrown out there are going to be one or another. As Joy said it's going to be more a combination, and a little bit of column A, B, C, and we're going to provide that in our response. Thank you.

MEMBER BALLINGER: Thank you. I'll ask one more time, are there any people out there that would like to make a comment? Okay, hearing none, now I'm not sure what the timing is, 11:30, we need to --

CHAIR REMPE: I think at this point we

could go off the record.

MEMBER BALLINGER: That's what I was about to say.

CHAIR REMPE: Okay, so then you want to turn it back to me, and I will release the court reporter for the entire meeting?

MEMBER BALLINGER: Okay.

CHAIR REMPE: Okay. So, thank you again for your presentations, and court reporter, we are done with your services for this entire meeting.

(Whereupon, the above-entitled matter went off the record at 11:27 a.m.)

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Regulatory Basis on Increased Enrichment of Conventional and Accident Tolerant Fuel Designs for Light-Water Reactors

November 2, 2023

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Opening Remarks

Scott Krepel
Branch Chief
Division of Safety Systems

NRC Staff Presenters

- **Philip Benavides, NMSS:**
  - Overview of Increased Enrichment Rulemaking
- **Charley Peabody, NRR:**
  - Criticality Accident Requirements (10 CFR 50.68)
- **Philip Benavides on behalf of Don Palmrose, NMSS:**
  - Environmental Regulations in 10 CFR 51.51 & 10 CFR 51.52
- **Jason Piotter, NMSS:**
  - General Requirements for Fissile Material Packages (10 CFR 71.55)
- **Elijah Dickson, NRR:**
  - Control Room Requirements (10 CFR 50.67 and GDC-19)
- **Joseph Messina & Ashley Smith, NRR:**
  - Fuel Fragmentation, Relocation, and Dispersal

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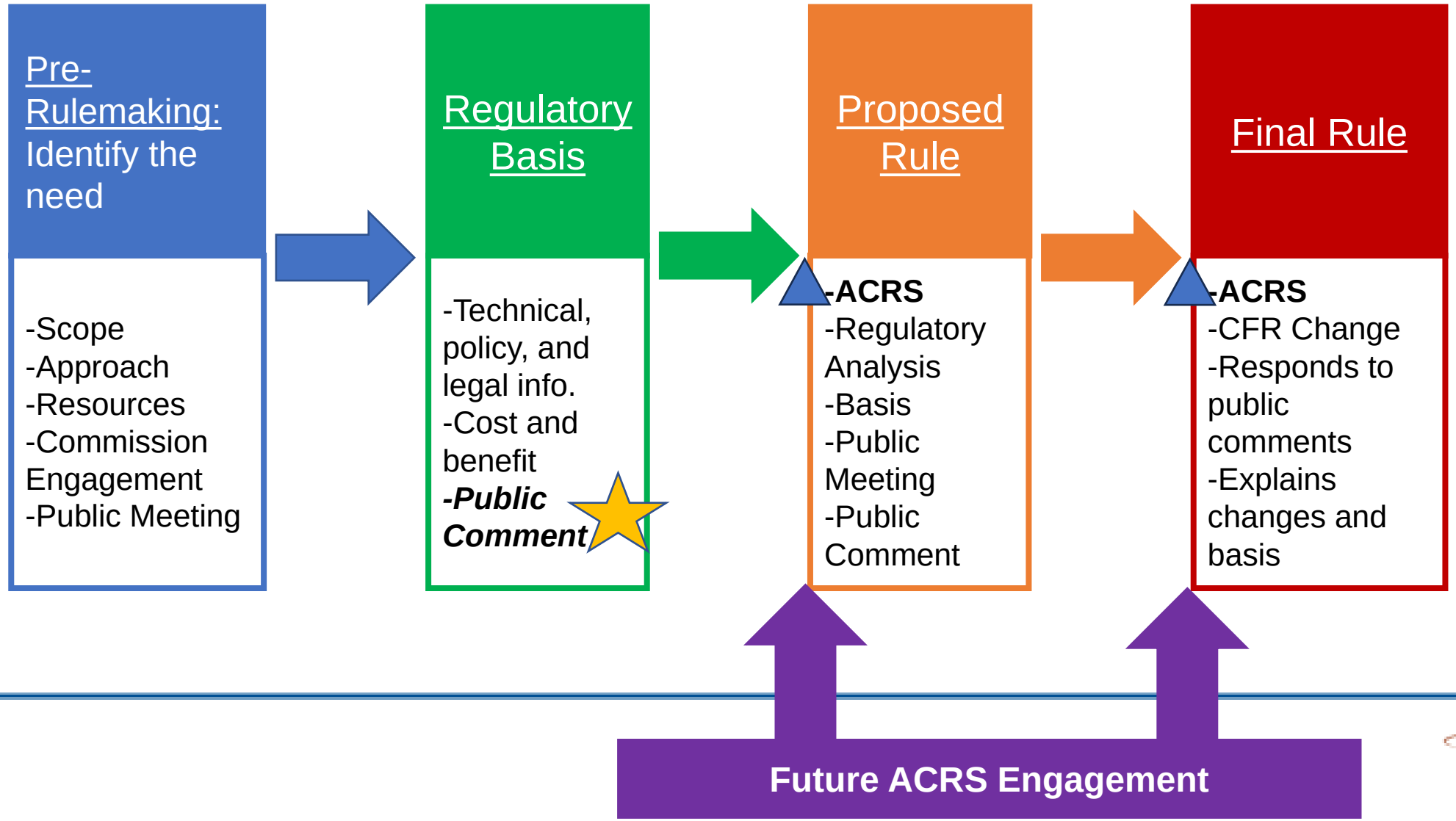
Overview of Increased Enrichment Rulemaking

Philip Benavides
Project Manager
Reactor Rulemaking & Project Management Branch

Rulemaking Process



Issue Identification

- **Regulatory Issue:**
  - Current licensing framework allows for the use of > 5 weight percent uranium-235; however, technology developments may require numerous exemptions to utilize fuel enriched above 5 weight percent uranium-235.
- **Proposed Solution:**
  - Rulemaking would provide for a generically applicable standard informed by public input, providing consistent and transparent communication, rather than individual licensing requests as discussed in SECY-21-0109, Rulemaking Plan on Use of Increased Enrichment of Conventional and Accident Tolerant Fuel Designs for Light-Water Reactors.
- **Commission Rulemaking Plan Approval:**
  - Staff request to the Commission to pursue rulemaking and develop a regulatory basis was approved by the Commission via SRM-SECY-21-0109 on 3/16/2022.

Status of Rulemaking Activity

- **The NRC staff issued a regulatory basis on September 8, 2023**
  - Discusses regulatory issues and alternatives to resolve them
  - Considers legal, policy, and technical issues
  - Considers costs and benefits of each alternative
  - Identifies the NRC staff's recommended alternative for most regulatory issues
    - FFRD: Alternatives offered with no recommendation at this time
- **ACRS Fuels, Materials, and Structures Subcommittee: October 18, 2023**
- **Stakeholder Involvement:**
  - Public Meetings held on June 22, 2022 & October 25, 2023
  - Comment Period until November 22, 2023
- **Proposed rule due to the Commission: December 2024**

Regulatory Basis Topics

- **The regulatory basis describes the evaluated technical topics:**
  - Criticality Accident Requirements (10 CFR 50.68)
  - Uranium Fuel Cycle Environmental Data - Table S-3 (10 CFR 51.51)
  - Environmental Effects of Transportation of Fuel and Waste - Table S-4 (10 CFR 51.52)
  - General Requirements for Fissile Material Packages (10 CFR 71.55)
  - Control Room Requirements (10 CFR 50.67 and GDC-19)
  - Fuel Fragmentation, Relocation, and Dispersal

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Criticality Accident Requirements of 10 CFR 50.68

Charley Peabody
Nuclear Systems Performance
NRR

Criticality Accident Requirements of 10 CFR 50.68: Summary of Regulatory Issue

- Rule utilizes k-effective acceptance criteria with required probability and confidence levels to permit exemptions to 10 CFR 70.24 active criticality monitoring and emergency planning requirements
- Current rule limits application to enrichments of ≤ 5% weight Uranium-235

10 CFR 50.68: Recommended Alternative

Staff Recommends Alternative 3: replacing the current enrichment limit with the Technical Specifications Design Feature limits

- Maintains existing subcriticality margins at the same k-effective probability and confidence levels
- Criticality safety impacts are addressed during the fuel transition license amendment request process
- Allows consideration of low-enriched uranium up to <20.0% weight
- Research Study with Oak Ridge National Laboratory
- Preserves the § 50.68(b) compliance for all existing fleet without backfit

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Environmental Requirements of 10 CFR 51.51 & 51.52

Donald Palmrose
Environmental Review New Reactors Branch
NMSS

Environmental Requirements of 10 CFR 51.51 & 51.52 Summary of Regulatory Issues

- The environmental data of Table S-3 (10 CFR 51.51(b)) and environmental impacts of Table S-4 (10 CFR 51.52(c)) are bounding for enrichments up to 5 wt % U-235.
- Currently no approved assessment of environmental impacts related to the uranium fuel cycle or transportation of fresh unirradiated fuel for increases greater than 5% U-235.
- NUREG-2266 is a draft report for comment that would support these tables to bound up to 8 wt % U-235
- Until further environmental evaluations are completed:
  - For Table S-3, advanced reactor construction and operation licensing requests could involve use of up to 20% U-235 and require case-by-case reviews.
  - For Table S-4, reactor licensing requests with shipments of fresh fuel with more than 5 wt % U-235, there would need to be a full description and detailed analysis of transportation impacts as directed by 10 CFR 51.52(b).

10 CFR 51.51 and 51.52: Alternatives

1. *No Action* - Maintain current regulatory framework by assessing environmental impacts from the uranium fuel cycle on a case-by-case site-specific basis
2. *Rulemaking* - Pursue the necessary environmental analysis to justify continued use of Table S-3 and Table S-4 for increased enrichment and then pursue rulemaking to modify both tables (**recommended**)
3. *Rely on Revised or Updated Environmental Analysis* - Rely on the updated analysis when reviewing licensing actions for the use of increased enrichment fuels

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Packaging Requirements of 10 CFR 71.55

Jason Piotter
Containment, Thermal, Chemical & Fire Protection Branch
NMSS

10 CFR 71.55: Options for seeking approval by Certificate of Compliance

(1) Evaluate UF_6 packages with optimum moderation § 71.55(b)

- current package design
- redesigned package

(2) Request an exemption to § 71.55(b)

- Exceptions to § 71.55(b)

(3) Request approval under § 71.55(c) **(Requires special design feature and adm. controls.)**

(4) Request approval under § 71.55(g) **(enrichment limited to 5 weight percent U-235)**

10 CFR 71.55: Rulemaking Alternatives

1. *No Action* - Utilize Existing Certificate of Compliance Options
2. *Rulemaking* - Increase Enrichment limit to < 20.0% wt U-235
3. *Rulemaking* - Remove Enrichment Limit

10 CFR 71.55(g)(4): Recommended Alternative

Staff Recommends Alternative 1: No Action

- To date, industry plans communicated to the NRC have not indicated that there would be enough requests for package approvals, for transporting UF_6 enriched up to but less than 20.0 weight percent U-235, to conclude that rulemaking would be the most efficient or effective process to support package approvals.
- All alternatives are nearly cost neutral in terms of implementation;

- FRN Question
  - Is there additional information that can be shared to augment comments made by the public in June 2022 regarding the need for rulemaking to support licensing new or existing UF_6 transportation package designs?

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Control Room Design Criterion of 10 CFR 50.67 and GDC-19

Elijah Dickson
Radiation Protection and Consequence Branch
NRR

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Summary of Regulatory Issue

- The history of fuel utilization for the current large light-water fleet has seen a gradual progression toward higher fuel discharge burnups and increased enrichments.

- In general, there has been enough margin in the facilities' design bases to accommodate the criterion even for power uprates of up to 120 percent of the originally licensed steady-state thermal power level.

- The NRC recognizes the challenges that licensees face to retain margin for operational flexibilities within their licensing basis and the small amount of margin to the control room design criterion itself.

- The NRC does not want to unnecessarily penalize licensees for seeking increased enrichments that may then result in margin reductions and thereby requiring licensees to perform potentially extensive analyses to demonstrate compliance without a commensurate increase in safety.

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Background – 1/2

- Objective: ensure the design of the control room and its habitability systems provide for a habitable environment allowing the operators to remain in the control room and not evacuate during an emergency. Ideally, the environment should be a “short-sleeved,” comfortable environment for the control room operators. Such an environment was perceived to facilitate operator response to normal and accident conditions.

- History: developed in the 1970s and amended in the 1990s, the criterion did not foresee how licensees currently operate their facilities and manage their fuel, consider fuel enrichments above 5 weight percent U-235, or maintain coherence with other regulations concerning the Commission's comprehensive radiation protection framework.

- Intent (Statements of Consideration for 10 CFR 50.67): “… the control room criterion does not imply that this would be an acceptable exposure during emergency conditions, or that other radiation protection standards of Part 20, including individual organ dose limits, might not apply. This criterion is provided only to assess the acceptability of design provisions for protecting control room operators under postulated DBA conditions. …”

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Background – 2/2

- Note: While the *design* criteria are computed in terms of "dose," they are "figures of merit" used to characterize the minimum necessary design, fabrication, construction, testing, and performance of the requirements for SSCs that are important to safety. They do not represent actual occupational exposures received during normal and emergency conditions, which are primarily controlled by 10 CFR Part 20, "Standards for Protection Against Radiation."

- Consider modifying the control *design* criteria to a higher, but still safe performance level; changes would not alter normal operational and emergency exposure limits controlled under 10 CFR Parts 20 and 10 CFR 50.47.

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Radiation Protection Regulatory Framework

- In **10 CFR Part 20**, the NRC applies these standards to all exposure situations—normal and emergency conditions—but also provides an explicit exemption for cases in which compliance would limit actions that may be necessary to protect health and safety.
- To provide reasonable assurance that adequate protective measures can and would be taken in a radiological emergency, the NRC has established emergency planning regulations in Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50 and planning standards for nuclear power reactors in **10 CFR 50.47**, "Emergency plans."
- The Emergency Plans provides additional regulatory provisions to bear on the control of occupational exposures during emergencies. Paraphrased from Section **50.47.(b).(11)** provides the following:

  "… Where the means for controlling radiological exposures shall include exposure guidelines consistent with EPA Emergency Worker and Lifesaving Activity Protective Action Guides."
- The guidelines for actions to protect valuable property is 10 rem where a lower dose is not practicable, the guidelines for actions to save a life or to protect large populations is 25 rem. These guidelines endorsed in Section **50.47.(b).(11)** is consistent with the position of **20.1001.(b).**

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Alternative 1

- *No Action - Maintain the current regulatory framework*
  - Continue to revise existing guidance with updated source terms when data become available and update transport models on an ad hoc basis as research and resources become available.
  - Plan to issue RG 1.183 Rev 2 in FY 2025.

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Alternative 2

- *Pursue Rulemaking to Amend the Control Room Design Criteria and Update the Current Regulatory Guidance Accordingly with Revised Assumptions and Models and Continue to Maintain Appropriate and Prudent Safety Margins*
  - Assess and identify a range of acceptable values based on sound regulatory and scientific recommendations.
  - Initiate new research and analyses for mechanistic transport models and re-baseline other several operational and human health assumptions
  - Plan to issue RG 1.183 Rev 2 in support of the amended control room design criteria.

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Alternative 3

- *Update the Current Regulatory Guidance with Revised Assumptions and Models and Continue to Maintain Appropriate and Prudent Safety Margins*
  - Initiate new research and analyses for mechanistic transport models and re-baseline other several operational and human health assumptions AND assess other mathematical methods, computational- and statistical approaches to reduce unnecessary conservatism and provide greater flexibility.
  - Plan to commence work on RG 1.183 Rev 3 based on new research and analyses soon after RG 1.183 Rev 2 is issued.

Control Room Design Criterion of 10 CFR 50.67 and GDC-19: Recommended Alternative

Staff recommends Alternative 2: Pursue rulemaking to amend the Control Room Design Criteria and update the current regulatory guidance accordingly with revised assumptions and models and continue to maintain appropriate and prudent safety margins

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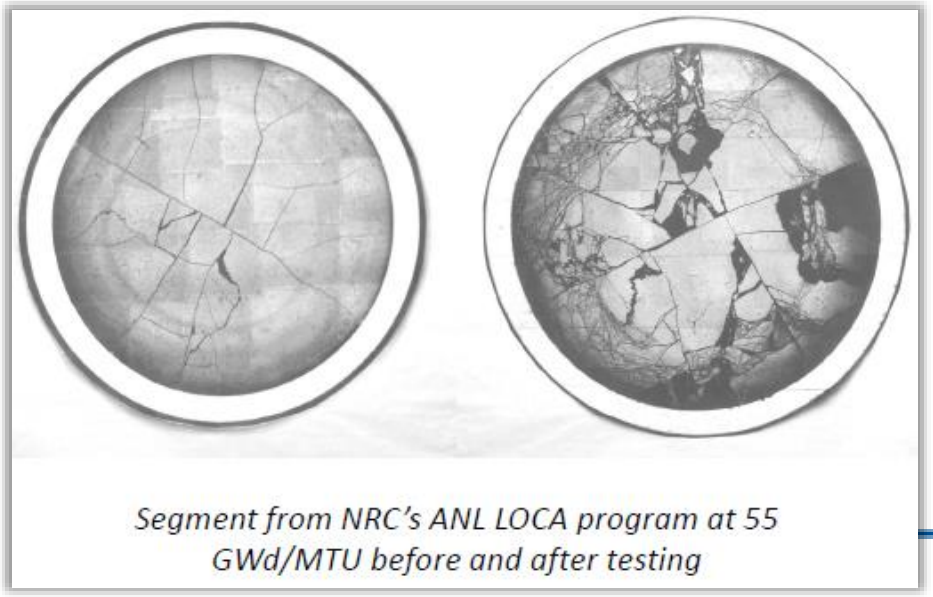
Fuel Dispersal

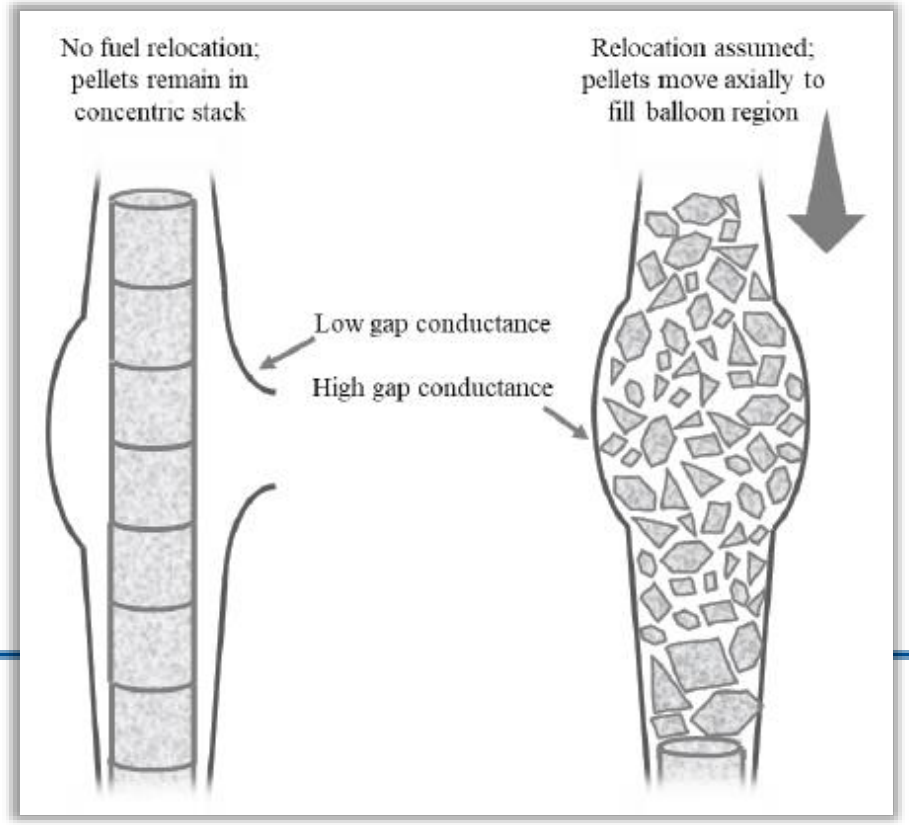
Joseph Messina
Ashley Smith
Nuclear Methods and Fuel Analysis
NRR

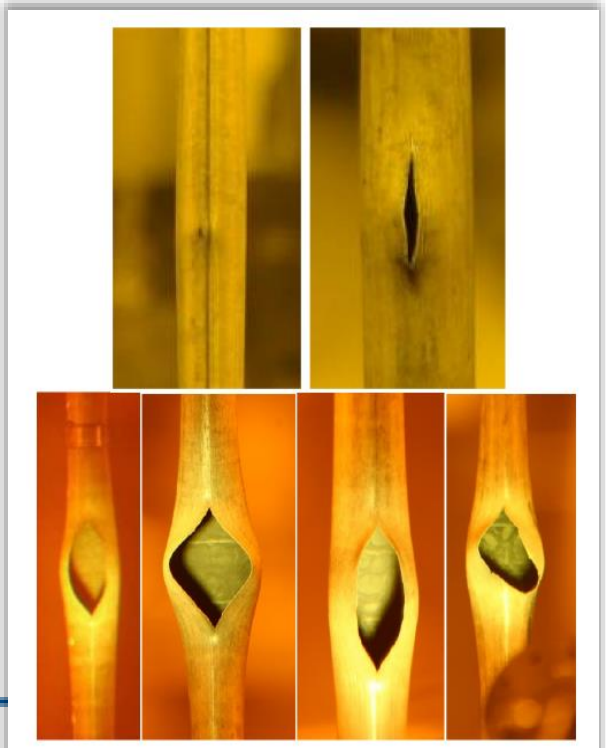
Fuel Fragmentation, Relocation, and Dispersal (FFRD)

- At HBU experiments have shown that the fuel can fragment during a LOCA
- Differences in pressure across the cladding can lead to cladding ballooning and burst
- The fragmented fuel can relocate axially into the balloon region of the fuel rod and if burst occurs, disperse into the RCS



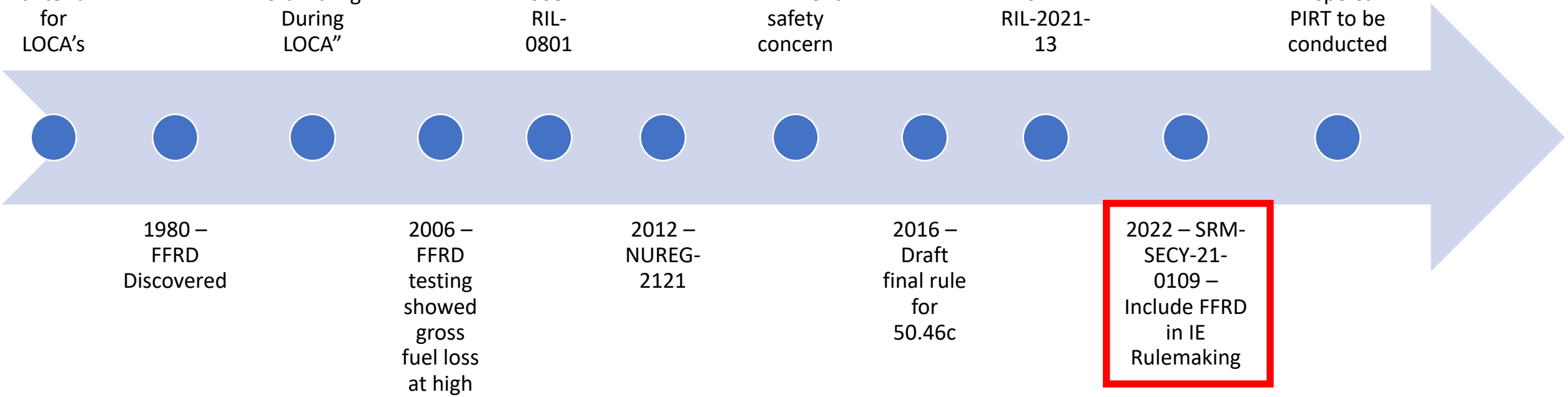
Segment from NRC's ANL LOCA program at 55 GWd/MTU before and after testing





Burst openings from Studsvik LOCA tests (NUREG-2121)

FFRD: History



Fuel Dispersal: Background and Regulatory Issue

- The 50.46 acceptance criteria date to 1974 when FFRD were not known phenomena
- Acceptable approaches to demonstrate compliance with the regulations have ensured that catastrophic failure of the fuel rod structure and loss of fuel bundle configuration are precluded
  - Fuel dispersal would be a departure of precedent
- Fuel dispersal is not explicitly addressed within the current regulations

Fuel Dispersal: Alternatives

- The NRC staff have developed 5 licensing pathways that could be pursued as a part of IE rulemaking
- Alternatives should be seen as mutually inclusive (i.e., combinations of elements from multiple alternatives could be considered)
- NRC staff may consider other approaches based on public comments

Fuel Dispersal Alternative 1

- **No action**
- No major updates to regulatory framework
- Apply existing regulations for treatment of dispersal
- Licensees could show that rods susceptible to fine fragmentation would not rupture to demonstrate compliance
- Consideration of significant fuel dispersal without any major regulatory updates → challenges and regulatory uncertainty
  - Licensing pathways considering significant dispersal are discussed as part of other alternatives

Fuel Dispersal Alternative 2

- **<u>50.46a-style modification of ECCS requirements</u>**
- 50.46a was a draft final rule in 2010 that proposed to establish a transition break size (TBS), above which LOCAs can be analyzed with more realistic assumptions
- Best-estimate modeling and more realistic assumptions *<u>may</u>* help to demonstrate that no rods susceptible to dispersal would burst
- Increased margin for other ECCS requirements (e.g., PCT)
- May impact Increased Enrichment rulemaking schedule

Fuel Dispersal Alternative 3

- **<u>Safety demonstration for post-FFRD consequences</u>**
  - Criticality, coolability, dose, long-term cooling, etc. should be addressed like any other LOCA phenomena
- Guidance would be issued with the rule, which could be updated to include more specific guidance after more research is performed
  - Current state-of-knowledge may lead to conservative guidance, but research could be performed in the long term to relax guidance
- May impact Increased Enrichment rulemaking schedule

Fuel Dispersal Alternative 4

- **Generic bounding assessment of dose and use risk insights for post-FFRD consequences**
- Dose criterion for LOCA with fuel dispersal would be established
- Licensees would demonstrate ability to predict a fuel dispersal source term or be directed to use a fraction of the MHA-LOCA source term based on the amount of predicted fuel dispersal.
- Downstream effects of dispersal could be treated as beyond design basis consequences and addressed with risk insights
  - E.g., insights from operating experience and other regulatory requirements, programs, and industry initiatives
- May impact Increased Enrichment rulemaking schedule

Fuel Dispersal: Alternative 5

- **<u>Probabilistic fracture mechanics to show that leaks in large pipes will be identified before failure, precluding the need to analyze LBLOCAs</u>**
  - E.g., leak-before-break and xLPR
- Derived from industry initiatives
- Licensees could use LBB to demonstrate that RCS leaks could be detected and operator action taken before a pipe breaks for a postulated LBLOCA, thus precluding a LBLOCA and fuel failure.
- May impact Increased Enrichment rulemaking schedule

Fuel Dispersal: Recommended Alternative

Staff Has No Recommendation at this time

- The staff has determined that additional stakeholder input is required before finalizing a recommendation.
- 6 questions are posed to the public in the FRN regarding fuel dispersal to better understand stakeholder perspectives.
- The staff will review the stakeholder input on fuel dispersal to determine the path forward during the proposed rule.

Fuel Dispersal: Alternatives

- Alternative 1: No action.
- Alternative 2: 50.46a-style modification of ECCS requirements.
- Alternative 3: Perform a safety demonstration for post-FFRD consequences.
- Alternative 4: Provide a generic bounding assessment of dose and use risk insights for post-FFRD consequences.
- Alternative 5: Use probabilistic fracture mechanics to show that leaks in large pipes will be identified before failure, precluding the need to analyze LBLOCAs.

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