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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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FUELS, MATERIALS AND STRUCTURES SUBCOMMITTEE

+ + + + +

WEDNESDAY

OCTOBER 18, 2023

+ + + + +

The Subcommittee met via Video
Teleconference, at 1:03 p.m. EDT, Ronald Ballinger,
Chairman, presiding.

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1 COMMITTEE MEMBERS:

2 RONALD G. BALLINGER, Chair

3 VICKI BIER, Member

4 VESNA DIMITRIJEVIC, Member

5 GREGORY HALNON, Member

6 JOSE MARCH-LEUBA, Member

7 ROBERT MARTIN, Member

8 DAVID PETTI, Member

9 JOY L. REMPE, Member

10 THOMAS ROBERTS, Member

11 MATTHEW SUNSERI, Member

12

13 ACRS CONSULTANT:

14 DENNIS BLEY

15 STEVE SCHULTZ

16

17 DESIGNATED FEDERAL OFFICIAL:

18 ZENA ABDULLAHI

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ALSO PRESENT:

MELANIE ANANIA, Interpreter

GAVIN GOBBLE BAKER, Interpreter

PHILIP BENAVIDES, NMSS

PAUL CLIFFORD, Public Participant

ELIJAH DICKSON, NRR

DONNA GILMORE, Public Participant

SCOTT KREPEL, NRR

EDWIN LYMAN, Public Participant

SANDRA McCLURE, Interpreter

JOSEPH MESSINA, NRR

SCOTT MOORE, ACRS

DON PALMROSE, NMSS

JASON PIOTTER, NMSS

ASHLEY SMITH, NRR

KALENE WALKER, Public Participant

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Adjourn

P-R-O-C-E-E-D-I-N-G-S

1:03 p.m.

CHAIR BALLINGER: Good afternoon. The meeting will now come to order.

This a meeting of the Fuel, Materials and Structures Subcommittee of the Advisory Committee on Reactor Safeguards. Today's meeting is virtual.

I'm Ron Ballinger, Chairman of today's Subcommittee meeting.

The ACRS members in attendance are Bob Martin, Dave Petti --

MEMBER SUNSERI: Matt Sunseri.

CHAIR BALLINGER: -- Matt Sunseri, Joy Rempe.

There's a lot of people. I'm struggling through here.

Steve Schultz, one of our consultants.

Tom Roberts, Vesna Dimitrijevic, Vicki Bier.

And I have probably missed somebody, like I did earlier this morning. But if I have, I apologize.

MEMBER MARCH-LEUBA: Jose. Jose is here.

CHAIR BALLINGER: Oh, Jose March-Leuba. Okay.

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1 So, if I've missed somebody, I apologize.

2 During today's meeting, Zena Abdullahi is
3 present as the DFO.

4 During today's meeting, the Subcommittee
5 will review the staff's regulatory basis for increased
6 enrichment of conventional and accident-tolerant fuel
7 designs for LWRs and will hold discussions with the
8 NRC staff and other interested people.

9 The ACRS was established by the Atomic
10 Energy Act and is governed by the Federal Advisory
11 Committee Act. The ACRS is independent of the ACRS
12 staff.

13 When applicable, ACRS issues publicly-
14 available letters that provide the Commission
15 independent technical reviews for NRC staff's Safety
16 Evaluations of licensees' amendments to their
17 operating licenses.

18 The Subcommittee will gather information,
19 analyze relevant technical topics/facts, and formulate
20 proposed positions and actions, as appropriate for
21 deliberation by the full Committee.

22 Again, today's meeting is being held
23 virtually over Microsoft Teams for ACRS staff members,
24 NRC staff, and the public.

25 There's a telephone bridge line that's

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1 been established, as well as a Teams link allowing
2 participation.

3 When addressing the Subcommittee, the
4 participants should, first, identify themselves and
5 speak with sufficient clarity and volume, so that they
6 may be readily heard.

7 When not speaking, we request that
8 participants mute their computer microphone or their
9 phone by pressing *6. If you don't do that, we'll
10 likely get feedback which will cause us issues.

11 And now, I think I need to turn it over to
12 Scott Krepel. Are you going to make initial comments,
13 Scott?

14 MR. KREPEL: (speaking through a sign
15 language interpreter throughout the proceedings) Hi.
16 Yes, I do plan to. Thank you.

17 I am Scott Krepel, speaking through a sign
18 language interpreter. And many of you know me. I am
19 the Branch Chief for the Nuclear Methods and Fuels
20 Analysis Branch. I'm presenting the Division of
21 Safety Analysis.

22 And I have to admit I was a little bit
23 disappointed when I found out that this would be
24 completely virtual because I can't sit on the side
25 table and see everybody in person today, but I do

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1 appreciate being here to take the opportunity to
2 discuss this topic. And I know that we will have more
3 to come on this topic in the future.

4 Soon, you will hear a presentation and you
5 will have the opportunity to ask questions on the
6 regulatory basis for the increased enrichment
7 rulemaking, which has been issued for public comment
8 just a few weeks ago.

9 This is part of a broad effort at the NRC
10 to prepare licensees for accident-tolerant fuel
11 technology and create advanced enrichment and advanced
12 technologies, as well as increased enrichment and high
13 burnup -- with the goal for energy independence and
14 climate change.

15 Hold on one second for the interpreter.

16 So, here in DSS, NMSS, and NRR, we are
17 working collaboratively together to make sure that
18 increased enrichment (audio interference) are
19 maximizing the licensees' ability for pursuing
20 business opportunities, for increasing their
21 enrichment, as well as all aspects of the fuel cycle.

22 Increased enrichment implies high burnup
23 because the licensees, you know, for them to be able
24 to maximize and take advantage of increased
25 enrichment, they would need to go through burnup from

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1 where they are currently licensed. And so, you will
2 hear some discussion about how the NRC plans to
3 address those issues related to high burnup as well as
4 fuel fragmentation, relocation, and dispersal, also
5 known as FFRD.

6 I look forward to your comments and
7 questions for this reg basis, and thank you for your
8 time. I appreciate you allowing me the time to give
9 my remarks.

10 CHAIR BALLINGER: This is Ron Ballinger.

11 I, too, am a bit saddened by us not being
12 in person. This is largely the result of the
13 potential shutdown, and things like that, that just
14 got things a little bit confused. So, I would have
15 liked to have seen in-person as well.

16 So, who is doing the presenting?

17 MR. BENAVIDES: Phil Benavides here. I'll
18 do the presenting.

19 Next slide.

20 CHAIR BALLINGER: Okay. Thank you.

21 MR. BENAVIDES: Yes.

22 Yes, thank you for your time.

23 I am Phil Benavides. I am a Project
24 Manager in the Office of Nuclear Material Safety and
25 Safeguards, assigned as the Project Manager to the

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1 rulemaking on the increased enrichment of conventional
2 and accident-tolerant fuel designs for light water
3 reactors. I'm going to provide an overview of the
4 enrichment rulemaking.

5 Next slide.

6 As a way to provide a background of how we
7 got to this point, I'd like to go back to the
8 beginning when the issue was identified. Throughout
9 the last few years, staff has seen an increased
10 interest from industry on the use of fuel enriched to
11 above 5 weight percent U-234.

12 The NRC noted that, although the current
13 regulatory framework allows for licensing of fuel
14 above 5 weight percent, the use of this fuel may
15 result in numerous exemptions requests for licensees.

16 So, as a solution, NRC staff began
17 pursuing rulemaking, rather than licensing by
18 individual exemption. In December of 2021, the staff
19 provided to the Commission SECY-21-0109, requesting
20 approval to begin the rulemaking process.

21 Slide 5, please.

22 In March 2022, the Commission granted
23 approval to begin the rulemaking process, as described
24 in the Staff Requirements Memorandum for SECY-21-0109.
25 The purpose of this rulemaking effort is to provide a

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1 comprehensive review of regulations and guidance that
2 may be impacted by the use of fuel enriched above 5
3 weight percent.

4 The Commission also specified several
5 considerations to evaluate, in addition to what was
6 specified in the rulemaking plan. These are listed in
7 the slide shown.

8 Specifically, the rule should apply to the
9 fuel enriched up to 20 weight percent, or HALEU. The
10 staff should address fuel fragmentation, relocation,
11 and dispersal, and take a risk-informed approach.

12 Slide 6.

13 The NRC issued a regulatory basis on
14 September 8th. This regulatory basis discusses the
15 regulatory issues and alternatives to resolve them;
16 considers legal, policy, and technical issues;
17 considers cost and benefits for each alternative, and
18 identifies the NRC staff-recommended alternative for
19 most regulatory issues, with FFRD being an outlier,
20 which we'll wait for public input received during the
21 public comment period.

22 Stakeholder involvement includes a public
23 meeting scheduled for October 25th and the public
24 comment period, which is open until November 22nd.

25 The proposed rule is currently due to the

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1 Commission December of 2024.

2 Slide 7, please.

3 The regulatory basis discusses these
4 technical topics.

5 Oh, sorry. Thank you. There's a
6 question?

7 MEMBER REMPE: Yes. This is Joy. Can you
8 hear me okay?

9 MR. BENAVIDES: Yes, we can hear you.

10 MEMBER REMPE: Great. I have a couple of
11 things.

12 First, just to make a point clear, the
13 public meeting will give you some input, but you do
14 not intend to have any additional thoughts on FFRD by
15 the November full Committee meeting? You don't plan
16 to elaborate and make a recommendation in the next
17 couple of weeks? Is that a true statement?

18 MR. BENAVIDES: That is a true statement.
19 We will wait for the comment period to close; use
20 those comments that are received to help inform our
21 path forward, while developing the proposed rule.

22 MEMBER REMPE: Okay. And then, the other
23 question I have, I wasn't sure where to put this. And
24 so, I'm just going to throw it out here now.

25 MR. BENAVIDES: That's okay.

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1 MEMBER REMPE: You know, it talks about
2 the Commission wanting you to deal with higher
3 enriched fuel, but, then, the title of this
4 presentation is also pertaining to accident-tolerant
5 fuel designs. And I realize we don't regulate to
6 beyond-design events.

7 But if we're going to include accident-
8 tolerant fuel designs, at some point, one needs to
9 think about the fact that You're going to be having
10 this extended period where the cladding still would
11 relocate at a temperature much lower than the fuel --
12 or excuse me, I'm sorry -- that the cladding would
13 relocate at a higher temperature, but the control rods
14 relocate at a much lower temperature still. So, you
15 have this extended period where the control rods are
16 gone and the better cladding that can stay at a higher
17 temperature -- and sometimes you see 30 minutes;
18 sometimes you see an hour.

19 But it seems like somebody needs to think
20 about this. The only place I could even think that
21 this might have come into play was with the Sandia
22 alternative source term update. And they did talk
23 about the fact they had the control rods go at a lower
24 temperature than the cladding and they bumped up the
25 fuel.

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1 But I didn't see anything about what the
2 staff is going to do with guidance or something. It's
3 going to have to require something to make sure you
4 have borated water and that you can appropriately
5 predict what would occur with having coolant added.

6 And how is the staff going to deal with
7 that issue? I'm glad to see a head shaking up and
8 down. So, you are aware of what I'm trying to say.

9 Thank you.

10 MR. BENAVIDES: Yes, I think that the
11 staff -- and I don't want to speak for Joey and
12 Ashley, when they get to their portion of the
13 presentation -- I think they're going to take whatever
14 comments that we receive during the public
15 meeting/public comment period, and then, they'll take
16 all that into consideration while going forward.

17 And I think a portion of that will also be
18 dependent on which alternative they're going with as
19 well. So, that will have to be part of what they
20 consider, as we move forward through that process.

21 Joey, do you want to wait?

22 MR. MESSINA: I think we can wait on it.

23 Elijah, did you want to say something on
24 that? I saw you shaking your head. I'm not sure if
25 you wanted to.

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1 MR. DICKSON: I have nothing to add to
2 that right now --

3 MR. MESSINA: Okay.

4 MR. DICKSON: -- at this point.

5 MEMBER REMPE: Well, I'm not hearing --
6 I'm not seeing anything in the 200-page document we
7 were provided that talked about that there could be
8 some concerns when you have the control rods gone, and
9 then, the fuel is still sitting there, about what the
10 operator action should be. And so, where will that
11 appear? In this rulemaking? Or will it at least
12 acknowledge that this may need some special
13 considerations?

14 MR. DICKSON: In the FFRD portion of the
15 rulemaking, Alternative 4 is one of the dose-based-
16 type alternative in regards to FFRD. And we do
17 discuss in there ways in which we would handle post-
18 reflood of the core and operator actions. EOP, SAMGs,
19 things of that nature, would be further explored
20 underneath that all.

21 MEMBER REMPE: Okay. So, I did not take
22 it when I looked through Alternative 4.

23 MR. DICKSON: Okay.

24 MEMBER REMPE: But I will go back and look
25 at it more carefully.

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1 Thank you.

2 MR. DICKSON: Understood. Yes.

3 MR. BENAVIDES: All right. Thank you,
4 Joy. Thank you, Elijah and Joey.

5 Let's see, on this slide, what does it
6 say? The regulatory basis discusses the technical
7 topics. They'll be described in detail by the NRC
8 subject matter experts during this presentation.

9 Elijah Dickson will discuss control room
10 requirements in 10 CFR 50.67 and GDC 19.

11 Charlie Peabody will discuss criticality
12 accident requirements in 10 CFR 50.68.

13 Don Palmrose will discuss those
14 environmental topics in 10 CFR 51.51 and 51.52.

15 Jason Piotter will discuss the general
16 requirements for fissile material packaging in
17 10 CFR 71.55.

18 And Joey Messina and Ashley Smith will the
19 topic of fuel dispersal, which is a part of the FFRD.

20 And with that, unless there's any
21 additional questions on the overview of the
22 rulemaking, we can move on to the technical topics.

23 All right. Thank you for your time.

24 And I'll hand it off to Elijah.

25 MR. DICKSON: Thank you very much.

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1 My name is Elijah Dickson. I'm a Senior
2 Reliability Risk Analyst in the Division of Risk
3 Assessment. I work in the Radiation Protection and
4 Consequence Branch in the Office of Nuclear Reactor
5 Regulation. And I'll be discussing the general
6 control room design criteria of 10 CFR 50.67 of
7 GDC 19.

8 Next slide, please.

9 GDC 19 and 10 CFR 50.67(b)(2), Item 3,
10 provide very specific dose-based criterion of 5 rem
11 total effective dose equivalent for demonstrating the
12 acceptability of the control room design.

13 The history of fuel utilization for the
14 current light water reactor fleet has seen a gradual
15 progression towards higher fuel discharge burnups and
16 increased enrichments in general. There's been enough
17 margin in the facility design basis to accommodate the
18 criterion, even for power uprates up to 120 percent of
19 the originally-licensed, steady-state thermal power
20 levels.

21 Increased power levels, enrichments, and
22 subsequent fuel burnup have a multifaceted impact on
23 the licensee's analysis of record, design-basis
24 accident radiological consequence analysis results.

25 A rule of thumb is that increased power

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1 has a linear effect on these results. An increase in
2 uranium-235 enrichment necessary to reach the desired
3 burnup levels increases the number of fissions in the
4 reactor core, which proportionately increases these
5 results.

6 The impact of higher burnup on
7 radiological consequence results is non-linear where
8 the abundance of different radionuclides, for the most
9 part, peak at different burnup levels. Therefore,
10 depending on how the reactor core is designed, with
11 increased uranium-235 enrichments, operated at higher
12 burnup levels to reach longer cycle times, the impact
13 on the consequence analysis results used to
14 demonstrate compliance with the control room design
15 criteria would increase and, subsequently, decrease
16 the retained margin maintained by licensees to provide
17 for operational flexibility.

18 The NRC recognizes the challenges that
19 licensees face to retain margin for operational
20 flexibility purposes within their licensing basis and
21 the small amount of margin to the control room design
22 criteria itself. The NRC does not want to
23 unnecessarily penalize licensees in seeking increased
24 enrichments that may, then, result in margin
25 reductions, and thereby, require licensees to perform

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1 potentially extensive analyses to demonstrate
2 compliance without a commensurate increase in safety.

3 On to slide 10, please.

4 I'll give a little bit of background.

5 The general objective of the control room
6 design criteria is to ensure the design of the control
7 room is habitability systems provide for a habitable
8 environment, allowing operators to remain in the
9 control room and not evacuate during an emergency.
10 Ideally, you can think of this as a short-sleeve
11 environment, comfortable for them to perform their
12 safety function in the event of an accident.

13 A little bit of history with the control
14 room design criteria is, it was really developed back
15 in the early '70s when the agency was developing
16 Appendix A of 10 CFR Part 50. It was later amended
17 when the agency finalized 10 CFR 50.67 -- that is the
18 accident source term -- back in the late '90s.

19 The criteria didn't foresee how the
20 licensees currently operate their facilities and
21 manage their fuel, considering fuel enrichments above
22 5 weight percent, or maintain coherence with other
23 regulations concerning the Commission's Comprehensive
24 Radiation Protection Framework, which will also be
25 discussed in later slides.

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1 Slide 11, please.

2 We would like to note that the design
3 criteria, while they are computed in terms of dose,
4 they are, in fact, figures of merit used to
5 characterize the minimum necessary design fabrication,
6 construction, testing, and performance of requirements
7 for safety-related SSCs.

8 They do not represent actual occupational
9 exposures received during normal and emergency
10 conditions, which are primarily controlled under
11 10 CFR Part 20, "Standards for Protection Against
12 Radiation," and the consideration of the modification
13 of the control room design criteria to a higher, but
14 still safe, performance level.

15 Changes would not alter normal operational
16 or emergency exposure limits controlled under Part 20,
17 and subsequently, within the emergency plans of 50.47.

18 On to slide 12, please.

19 The staff reviewed and analyzed three
20 different alternatives, and I'll go through each of
21 them here.

22 The first alternative, no action. We
23 would be maintaining the current regulatory framework.
24 We would continue to revise existing guidance with
25 updated source terms when data becomes available and

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1 update transport models on an ad hoc basis, as the
2 research and resources become available. We plan to
3 issue this work in Reg Guide 1.183, Rev 2., in fiscal
4 year 2025.

5 On to slide 13, please.

6 Alternative two is to pursue rulemaking to
7 amend the control room design criteria and update the
8 current regulatory guidance accordingly with revised
9 assumptions and models, and continue to maintain
10 appropriate and prudent safety margin. The staff has
11 already assessed and identified a range of acceptable
12 values, based on sound regulatory and scientific
13 recommendations. We would be initiating research and
14 analyses for mechanistic transport models and re-
15 baseline several other operational and human health
16 assumptions. We plan to issue this work in Reg Guide
17 1.183, Rev 2, in support of the amended control room
18 design criteria.

19 On to slide 14, please.

20 Slide 14 is our most research-intensive
21 alternative. We would be updating regulatory guidance
22 with revised assumptions and models, and continue to
23 maintain appropriate and prudent safety margin. Just
24 like alternative two, we would be initiating new
25 research and analyses to develop mechanistic transport

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1 models and re-baseline several other operational and
2 human health assumptions. And we would be assessing
3 other mathematical methods, computational statistical
4 approaches, to reduce unnecessary conservatisms and
5 provide greater flexibility. The plan to commence
6 work on Reg Guide 1.183 would be based on the research
7 that would be wrapped up in Rev 2, when it's issued in
8 fiscal year 2025.

9 On to slide 15, please.

10 Our recommendation. The staff recommends
11 Alternative two and amended control room design
12 criteria and revision to applicable regulatory
13 guidance, considering risk information would be the
14 most cost-beneficial, straightforward, durable, and
15 efficient path forward, when licensing increased
16 enrichments up to 20 weight percent uranium-235.
17 Beneficial impacts on other regulations, such as 50.59
18 and Part 20, would also be realized.

19 It would be flexible enough to consider
20 multiple approaches in amending the regulation and
21 would provide options for a generic resolution to the
22 issues. We would be inviting stakeholder
23 participation on the decision affecting this
24 regulatory area, rather than on a case-by-case basis
25 that would result from the current regulatory

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1 framework.

2 The staff would use ample operating
3 experience, scientific data, technical information,
4 numerous recommendations from national/international
5 organizations responsible for radiation protection
6 standards and regulatory precedents that would support
7 a reevaluation of the control room design criteria.

8 In general, there is a range of regulatory
9 base and external stakeholder base recommendations for
10 radiation exposures to radiation workers under normal
11 and emergency conditions. Per the regulation,
12 occupational workers can technically receive 10 rem
13 over a 12-month period that straddles two calendar
14 years or 10 rem in a specific calendar year, given
15 special circumstances.

16 As well, intergovernmental, national, and
17 international organizations recommending emergency
18 exposures. These recommendations we found range from
19 10 to 25 rem or up to 50 rad whole body. As such, the
20 control room design criteria intended to assess the
21 acceptability of a given control room design is on the
22 lower side of these recommended values.

23 And with that, I would like to end my
24 presentation here and open it up for questions from
25 the Committee.

1 Mr. Roberts?

2 MEMBER ROBERTS: Yes. Elijah, I had a
3 similar question, one I was about to ask at the Reg
4 Guide 1.183 meeting last month.

5 MR. DICKSON: Which is?

6 MEMBER ROBERTS: The verbiage that you had
7 a couple of slides ago talks about emergency and
8 accident conditions, which isn't specific to whether
9 that's a postulated accident from the design basis,
10 whether it could be a severe accident that's beyond
11 the normal design basis.

12 And the prescription for calculating both
13 the control room dose and the technical support center
14 dose are based on kind of a mix of a very conservative
15 fission product release combined with an assumption
16 that the containment meets its normal design
17 assumptions.

18 And so, I was wondering if you had any
19 perspective on what kind of control room doses or
20 technical support center doses would be associated
21 with a severe accident and what's the perspective on
22 it, and where that fits into the overall objectives
23 you are working towards.

24 MR. DICKSON: Right. Right, right. I
25 mean, that's actually a very good point. And I'm glad

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1 you brought that up.

2 You know, there is quite a bit of work
3 that has been done in post-Fukushima work, right? And
4 that's probably one of the best resources to look at
5 to understand how a licensee handled responding to the
6 accident and the incurred doses that were actually
7 incurred.

8 And there's a very, very good document out
9 there. It's published by IAEA. It's IAEA Publication
10 1710 that talks about the number of people that were
11 onsite during the accident itself; the number of
12 people that they tracked during, I think it's like a
13 10-month period or so, and the measured doses that
14 they received during that time.

15 And for the most part, the vast majority
16 of the workers were below their regulatory limit. A
17 handful of them, about 170ish or so, were above their
18 threshold of 10 rem, I think, and there was a couple
19 of outliers in regards to people receiving, I think,
20 doses as high -- these aren't people directly in the
21 control room, but people doing actual actions outside,
22 you know, in the plant responding to this very much
23 beyond-design-basis scenario. And they attributed
24 some of those higher doses to internal intakes and
25 training, actually.

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1 MEMBER ROBERTS: Right. So, in terms of
2 overall perspective --

3 MR. DICKSON: Did that answer your
4 question?

5 MEMBER ROBERTS: Yes. In terms of overall
6 perspective, yes, a change to the control room dose
7 requirements, you know, doubling from 5 to 10 rem,
8 say, would, essentially, double the allowed exposure
9 during one of these severe accident or emergency
10 scenarios.

11 And I was trying to understand the
12 perspective. Is there any analysis that a 5 rem dose,
13 per the current analysis methods, corresponds to some
14 sort of dose in a severe accident? Or is there any
15 kind of correlation you could draw that would say,
16 well, doubling that is still within the realm of
17 reason, or whether that would potentially be a problem
18 that isn't there currently?

19 MR. DICKSON: Well, it is within the realm
20 of reason. This is a figure of merit used to assess
21 the acceptability of all the SSCs used to mitigate
22 that source term. It doesn't take in all of the other
23 types of operator actions and emergency replanning-
24 type actions that go into actually controlling the
25 dose during an actual event, right?

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1 And so, the NRC does have emergency plans
2 under 50.47, I believe, that handles ALARA situations
3 and things of that nature, when they're actually
4 responding to an actual event.

5 During those times, they would be
6 practicing ALARA practices. They could always issue
7 prophylactics such as potassium iodine, too, as well,
8 to keep doses low. That does a very, very good job of
9 blocking exposure to one's thyroid, which is really
10 the driving, I guess, dose in these DBA calculations.

11 MEMBER ROBERTS: Sure. I understand that
12 you certainly would take those actions to try to
13 minimize the consequence of the outliers.

14 MR. DICKSON: Uh-hum.

15 MEMBER ROBERTS: I was, again, just trying
16 to understand if there was any expectation of what
17 those kinds of dose rates would be. The direct report
18 that you issued had a footnote -- I think it was
19 footnote 6 -- that says that the current PRAs don't
20 look at dose in terms of estimating the likelihood of
21 operator actions that are credited being taken, which
22 kind of surprised me.

23 So, it seems like there's an open question
24 of is there a generic desire to keep the control room
25 and the technical support center staffed during a

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1 severe accident, or is that not considered to be
2 important? And again, if it is to be important, it
3 seems like there ought to be some assessment of what
4 the habitability conditions are and why they support
5 the actions that are credited.

6 MR. DICKSON: Understood. There are the
7 TMI action plan items, too. I think, specifically,
8 Action Item 2(b)(2) used in regards to assessing
9 mission doses -- to perform certain actions within the
10 plant and things of that nature, too.

11 So, there are assessments in that when
12 they are in these beyond-design-basis conditions.

13 MEMBER ROBERTS: Yes. Okay. Thank you.

14 We probably need to have more discussion
15 in terms of --

16 MR. DICKSON: Uh-hum, understood.

17 MEMBER ROBERTS: -- understanding what
18 kind of the integrated story of here's what the
19 expectation is for control room and TSC dose.

20 MR. DICKSON: Absolutely.

21 MEMBER ROBERTS: Here is whatever
22 assessments exist that support those expectations.

23 MR. DICKSON: Uh-hum.

24 MEMBER ROBERTS: So, I just want to leave
25 it at that here.

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1 Thank you.

2 MR. DICKSON: Okay. Thank you.
3 Appreciate it.

4 Yeah. So, we are looking, there's a
5 number of areas that we're looking at right now. You
6 know, as we had spoken in the full committee meeting
7 and the subcommittee meeting on Reg Guide 1.183,
8 there's been -- the staff are, you know assessing and
9 looking at the latest Sandia that takes integrations
10 up to 8 to 10 percent, depending on if it's a PWR or
11 BWR and brings it to 80 gigawatt days per NTU.

12 And, we're looking at, you know, how to
13 best use those, that information. And, some of the
14 information that we are looking at speaks to the idea
15 of looking into mechanistic transport models.

16 And so, often what we hear is that, you
17 know, with these updated source terms, you know,
18 there's a Sandia 2011 source term. There is this
19 latest one. And then, the precursor to all of them is
20 NUREG-1465.

21 And, we're constantly seeing the halogens
22 increase right, from one source term to another. And,
23 that is the containment source term.

24 And, when folks look at those Tables, they
25 see that, you know, the halogens are increasing from

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1 one analysis to another. But, that's only part of the
2 story, right.

3 For instance, in BWRs when you look at
4 some of the tables in that 2023 report in the back,
5 when they talk about things like suppressor pool
6 scrubbing and whatnot, they do make a distinction that
7 a lot of the containment source term that does include
8 the dry well and the wet well of a BWR, is actually
9 retained in the wet well, in the water. Right.

10 It does a very, very good job of retaining
11 those radionuclides, if they can maintain their PH at
12 a certain level. And so, we're looking into, you
13 know, can information be gleaned from that report in
14 regards to some of the other transport models that we
15 use in the guide.

16 And so, that's an area of continued
17 research. I'm not really prepared to talk about any
18 of that right now. But, I do know that the Office of
19 Research will be having discussions with you in the
20 next couple of months, I believe, on that subject.

21 MEMBER REMPE: Actually, it'll occur in
22 mid- November on the critique is what I'm seeing now.

23 MR. DICKSON: Okay. Fair.

24 MEMBER REMPE: I think that would be very
25 helpful for us as we try to contemplate how to go

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1 through with this.

2 MR. DICKSON: Understood.

3 MEMBER REMPE: But, it sounds to me like
4 You're going to try and -- because, I mean, actually
5 that report had a higher source term.

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

7 MEMBER REMPE: And so, this thing about
8 trying to have a reduced one, I'm not sure that report
9 is going to give you much in its current state, even
10 if it does get the review that, you know, if somebody
11 finds something wrong with it, they may have to redo
12 it.

13 But, it sounds like that you want to
14 actually have a lot of research and then have them
15 update that source term again, is your assessment.

16 MR. DICKSON: So, we're gleaning
17 information from the report right now. And, I think
18 it's like Section Five of that report, they talk about
19 like air/soil retention.

20 And, they do present a series of tables in
21 that report that demonstrate how much of this
22 containment source term is actually divvied up between
23 the wet well and dry well. And, in the 2023 report,
24 I think 70 percent of the halogens are deemed to be in
25 that containment that includes both wet well and dry

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1 well.

2 But, if you look at Table, it's like 5.14
3 or 5.15, you can see that 90 percent of that source
4 term is actually in the wet well. So, that's -- we're
5 looking at that type of information.

6 MEMBER REMPE: Is there -- since this is
7 something being done to help future applicants, why
8 not have them pay for this research instead of the NRC
9 paying for this research to come up with this report
10 and such?

11 MR. DICKSON: Right.

12 MEMBER REMPE: That's another question
13 that crossed my mind when I was reading all of this.

14 MR. DICKSON: It's, I mean, it's a
15 question that's crossed my mind. We would -- we would
16 always accept another alternative source term for
17 review.

18 The Agency has always provided this
19 maximum hypothetical source term historically, dating
20 back from the TID source term of the early '60s, to
21 14.56.

22 But, like the new, the new reactors,
23 NuScale, GE, Holtec, you know, they're looking into
24 developing their own source terms as well. NuScale
25 did. You know, NuScale did use their own source term,

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1 accent source term.

2 MEMBER REMPE: But, you do think this is
3 something the Agency does need to do, just because
4 it's historically been done, is what You're telling me
5 today?

6 MR. DICKSON: Historically yes. And, it's
7 good for the Agency to kind of put that, I guess this
8 is my own personal perspective, like that, you know,
9 kind of flag in the sand that, you know, we've done
10 this work and this is what we think is a reasonable
11 source term for these types of analysis.

12 And then, gain, you know, stakeholder
13 feedback and involvement in regards to, is this the
14 right source terms. So, yeah, I think so.

15 MEMBER REMPE: Okay. Thank you.

16 MR. DICKSON: Um-hum. Okay. If there are
17 no other questions, we can move on to Charlie Peabody,
18 who will be presenting on criticality accident
19 requirements of 10 CFR 50.68.

20 Thank you.

21 MR. PEABODY: All right. Thanks, Elijah.
22 Can everybody hear me on the room microphone?

23 CHAIR BALLINGER: Okay by me.

24 MR. PEABODY: Good to hear. Okay. So,
25 this is going to be a discussion of the criticality

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1 accident requirements that we're looking as part of
2 this rulemaking. Next slide, please.

3 We're focusing primarily on changes that
4 we're going to make to 50.68. But, this is actually
5 a combination of 10 CFR 50.68 and 10 CFR 70.24.

6 70.24 was the initial rule for criticality
7 safety for fuel storage. It does not have an
8 enrichment limit in it.

9 However, we made 50.68 as a final rule in
10 1998 because 70.24 had requirements that licensees
11 considered burdensome. Mostly that in addition to
12 active criticality monitoring, it also required
13 emergency planning procedures and drills for a full
14 evaluation and rehabilitation of the storage
15 facilities.

16 So, that final rule permits exemptions so
17 there's parts of 70.24 requirements. And, it does
18 that by limiting enrichments to 5 percent weight.

19 And, the way that it does it is that it
20 analyzes the K effective with acceptance criteria that
21 require probability in confidence level.

22 So, if you have a sufficient margin of
23 subcriticality, you can be exempt of the active
24 emergency planning requirements of 70.24.

25 This rule is applicable to Part 50 and 52

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1 licensees, that they have to specifically adopt it as
2 part of the license. Next slide, please.

3 And so, some alternatives that we're
4 considering to 50.68, one would be no action. We've
5 had a couple of licensees come in asking for
6 exceptions to the 50.68 (b) (7) enrichment limit, which
7 we can grant under 50.12.

8 The second option would be a rulemaking to
9 actually increase the enrichment limit from the
10 existing 5 percent level to some other value up to 20
11 percent.

12 And then, the third alternative would be
13 to also do a rulemaking, which would just simply
14 remove the specific enrichment in 50.65(b) (7), and it
15 said, referenced the Tech Spec design feature limit.

16 And, that's the one that we're
17 recommending. Next slide, please.

18 The reason why we're recommending this is
19 because it maintains the existing subcriticality
20 levels at the same effective probabilities and
21 confidence.

22 But, criticality safety impacts will be
23 addressed during the fuel transition license amendment
24 request process. And, it also allows consideration of
25 any enrichment from the existing 5 percent value up to

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1 20 percent weight, which is the maximum allowed under
2 50.64.

3 We're also doing a study with Oak Ridge
4 National Lab that's going to kind of determine the
5 feasibility of enrichments for the existing, three
6 existing really commercial fuel designs. That we want
7 to make sure that we have somewhat of a sanity check
8 on the effects of increasing the enrichment on the
9 criticality K effective limits.

10 And one of the best things about this, I
11 think it's the last one that this preserves 50.68
12 compliance for all of the existing fleets who are not
13 affected, because if they were to ask for a higher
14 enrichment that would be a voluntary initiative.

15 They can keep the current enrichments that
16 they have without having to make any changes. Next
17 slide.

18 So, questions about 50.68?

19 Okay. I'm not seeing any. But, I'm
20 seeing Don, So, I'll get --

21 MEMBER PETTI: No, I have a -- this is
22 Dave. I have a question. Go back a couple of slides.

23 I know the preferred option was to take
24 out the specific emission limit today. But, the K
25 effective still stays the same. Is that correct?

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1 MR. PEABODY: Yes. So, the K effective
2 limits and (b)(2), (b)(3), and (b)(4) will be the
3 same. (b)(2) and (b)(4) are most limiting. That's
4 going to maintain .95 or 95 percent probability and
5 confidence for wet storage fuel and spent fuel.

6 We will also keep the (b)(3) limit for
7 optimal modernization of like the aqueous bond
8 analysis. If anyone wants to use that then we're not
9 seeing -- we're not planning on removing it. But,
10 it's not utilized at many sites, because most of them
11 are not storing fuel in the, storing new fuel in that
12 storage.

13 MEMBER PETTI: Okay. Thanks.

14 MR. PEABODY: Any other questions?

15 And with that, I'll turn it over to Don
16 Palmrose to discuss environmental considerations.

17 MR. PALMROSE: Okay. Good afternoon. And
18 a quick sound check. Can you hear me okay?

19 MS. ABDULLAHI: Yes.

20 MR. PALMROSE: Okay. Thank you. Yes.
21 Again, I'm Don Palmrose and I'm the Senior Reactor
22 Engineer with environmental center expertise. So,
23 let's go to the next slide, please.

24 Okay. So, the annual fuel cycle and the
25 transportation of fuel waste are connected actions up

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1 to operating, operational use in nuclear power plants
2 under NEPA, the National Environment Policy Act.

3 The staff has previously performed genetic
4 analysis dating back to the 1970s to evaluate the
5 environmental effects of the uranium fuel cycle and
6 the transportation of fuel and waste. These
7 evaluations are documented in WASH 12.48, for the
8 uranium fuel cycle, and then WASH 12.38 for the
9 transportation of fuel and waste, along with other
10 supporting documents.

11 This original analysis was for enrichment
12 levels up to 4 percent, U-235. The uranium fuel cycle
13 analysis was codified into 10 CFR 51.51 as Table S-3.
14 For the transportation of fuel and waste, the
15 environmental effects were codified into 10 CFR 51.52
16 as Table S-4.

17 Subsequent staff evaluations expand the
18 Table S-3 and S-4 to up to 5 weight percent U-235. Of
19 note for Table S-4, there are other conditions that
20 must also be met to use Table S-4 in a licensing
21 action, else a full description and detailed analysis
22 of the transportation impacts would need to be
23 performed as part of the licensing action.

24 The staff has performed additional
25 analysis to extent the measurement levels above 5

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1 weight percent U-235. This has been done in two
2 documents.

3 The first is a study to support accident
4 tolerant fuel deployment published in NUREG-2266,
5 which is currently available for public comment until
6 October 31.

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

11 Until these documents have been finalized,
12 the current practice for addressing these environment
13 impacts continues as before, as shown in the last two
14 sub-bullets, where the uranium fuel cycle evaluation
15 would be on a case by case basis, as lived on in prior
16 new reactor applications.

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

20 The staff considered three alternatives
21 for 51.51 and Table S-3. The first is the current
22 situation as I previously mentioned on the previous
23 slide. Address the environmental effects on a case by
24 case basis.

25 The recommended alternative is to

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1 incorporate the updated evaluation in NUREG-2266 and
2 the advanced reactor generic environmental impact
3 statement into the regulations, apply this rulemaking
4 to extend Table S-3 to the highest metric levels these
5 analysis can support.

6 The third alternative would be not to
7 codify the updated evaluations. But, reference them
8 for the environmental findings into individual
9 licensing actions. Next slide, please.

10 The same alternatives were also considered
11 for 51.52 and Table S-4. Again, with the rulemaking
12 and the recommended alternatives.

13 And, with that, that ends my presentation.
14 And I'm available for questions.

15 If there are no questions, I'll pass it
16 onto Jason.

17 MR. PIOTTER: Thanks, Don. My name is
18 Jason Piotter. I'm a Senior Mechanical Engineer and
19 the Senior Program Manager for ATF and Advanced Fuels
20 in the Division of Fuel Management in the Office of
21 Nuclear Material Safety and Safeguards.

22 Today I'm just going to give a brief
23 overview of the packaging requirements of 10 CFR 71.55
24 as it relates to increased enrichment.

25 For this particular effort, the Division

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1 of Fuel Management reviewed applicable regulations in
2 10 CFR Part 71 and 72, to identify any areas where a
3 specific reference to fissile materials enrichment
4 levels was evident.

5 No regulations in Part 72 were identified
6 with an enrichment limitation. And, the regulations
7 in 10 CFR Part 71 do not directly reference or limit
8 enrichment level of the radioactive contents except
9 for 10 CFR 71.55(g) or golf.

10 This provision allows an applicant for a
11 certificate of compliance to utilize an exception to
12 10 CFR 71.55(b) or bravo, and is applicable only to
13 UF6 transport. It specifies an enrichment limit of 5
14 weight percent U-235 per UF6, which does not currently
15 bound the range of enrichment that applicants may
16 choose to ship in their UF6 transportation packages in
17 the future.

18 The regulation at 10 CFR 71.55(b) requires
19 that a single transportation package be designed and
20 constructed and its contents so limited that it would
21 be subcritical if water were to leak into the
22 containment system. This nonmechanistic criticality
23 analysis with moderation ensures criticality safety
24 during transport in the event that moderator leaks
25 into the containment vessel.

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1 The exception to 10 CFR 71.55 (b) contained
2 in 10 CFR 71.55(g) codified a longstanding NRC and
3 worldwide practice for evaluating watering leaking
4 into UF6 packages.

5 The NRC determined at the time that
6 including the exception in 10 CFR 71.55(g) was
7 warranted, because it would maintain consistency with
8 domestic and worldwide practice that operational
9 experience demonstrated safe shipment of fissile
10 material enriched too less than or equal to 5 weight
11 percent U-235 and that the necessity to transport an
12 essential commodity. And, those were taken directly
13 from 69 FR 3697 in 2004.

14 The particular exception for a UF6
15 transportation package can be used if all of the
16 following conditions in addition to the enrichment
17 limitation are met. The UF6 cylinder remains leak-
18 tight following a test specified for the hypothetical
19 accident conditions; the valve body of the cylinder
20 does not impact any other part of the package other
21 than where it is attached to the cylinder; there is
22 adequate quality control in the manufacture,
23 maintenance, and repair of packaging; and, each
24 package is tested to demonstrate closure before each
25 shipment. Next slide, please.

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1 Absent using the exception in 71.55(g),
2 applicants for a certificate of compliance have the
3 option of evaluating fissile materials packages,
4 including UF6 packages, in a variety of ways. Number
5 one, with the provisions under 71.55(b), which may
6 require changes to current package designs or perhaps
7 require new package designs to accommodate higher
8 enrichments.

9 An applicant may seek an exemption to
10 71.55(b) or they may use the provisions in 71.55[©].
11 71.55[©] is a -- it also provides for an exception to
12 the requirements of 71.55(b) if the applicant
13 specifies that the package incorporates special design
14 features that ensure no single packaging or would
15 permit leakage.

16 And, that appropriate measures are taken
17 before each shipment to ensure the containment system
18 does not leak. This exception does not limit the
19 enrichment of the package contents. Next slide,
20 please.

21 Based on its evaluation, the staff
22 identified three alternative actions that the NRC
23 could take. The first is no action, utilizing the
24 existing certificate of compliance options.

25 The second option would be to undertake

1 rulemaking to increase the enrichment limit up to 20
2 weight percent U-235. Or undertake rulemaking to
3 remove the enrichment limit completely. Next slide,
4 please.

5 The current staff recommendation at this
6 point is to take no action. To date, industry plants
7 communicated to the NRC have not indicated that there
8 would be enough requests for package approvals for
9 transport of UF6 enriched up to but less than 20
10 weight percent U-235 to conclude that rulemaking would
11 be the most efficient or effective process to support
12 package approvals.

13 All alternatives that were considered
14 under nearly cost neutral in terms of implementation
15 but the proportional burden is different for each of
16 those cases.

17 I would like to note here, that we have
18 recently approved a UF6 package with content enriched
19 too just under 20 weight percent, which followed the
20 regulation in 71.55(b) rather than seeking an
21 exemption or using the exceptions in 71.55[©] or
22 71.55(g).

23 We do have an existing question that is in
24 the FRN right now that we are seeking any additional
25 information that stakeholders can provide to us that

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1 might bolster the information that we did get back in
2 the public meeting in June, which essentially was a
3 single question that we had relating to how we were
4 going to interface with DOT and make sure that we were
5 harmonized with DOT regulations.

6 And then, of course, that subsequently
7 leads into how we would be harmonized potentially with
8 IAEA regulations.

9 So, with that, next slide, please. And,
10 I will take any questions.

11 MEMBER REMPE: So, this is Joy. I was
12 curious about if there won't be enough requests. Did
13 anyone indicate that they had a request?

14 MR. PIOTTER: We had gotten no --

15 MEMBER REMPE: Was there any questioning?

16 MR. PIOTTER: We had gotten no additional
17 feedback. I mean, I think currently the fleet that
18 exists is fairly modest.

19 And, I think the fact that we were, at the
20 time we were undertaking a COC evaluation of a package
21 that was going to be able to ship up to 20 weight
22 percent.

23 I wouldn't say that the problem is solving
24 itself. But, there are obviously options that the
25 industry has, multiple options that are performance

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1 based within the regulation.

2 That it appears as if we may not be seeing
3 a large influx or a demand signal for additional
4 packages. We don't know that, which is why we're
5 seeking additional information from industry.

6 MEMBER REMPE: Okay. Thank you.

7 MR. PIOTTER: Any other questions?

8 Okay. I think Phil, we are at a break.
9 Is that correct?

10 CHAIR BALLINGER: I think so. We've
11 actually -- well, I'm anticipating that the next topic
12 is going to have a pretty long discussion.

13 So, I think You're correct. Why don't we
14 take a break. It is now 1:55. Why don't we take a
15 break until 2:15, unless there's an objection?

16 Hearing none, we'll take a break until --
17 and reconvene at 2:15.

18 (Whereupon, the above-entitled matter went
19 off the record at 1:56 p.m. and resumed at 2:15 p.m.)

20 CHAIR BALLINGER: Okay. By my watch it's
21 2:15, and we're back in session. So, I think it's --
22 is it Joe or Ashley they're going to do the
23 presentation?

24 MR. MESSINA: Ashley's going to start off
25 and then she'll hand it over to me.

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1 CHAIR BALLINGER: Okay. Your show.

2 MS. SMITH: Okay. Hi, I'm Ashley Smith.
3 Joey and I are here for the fuel dispersal portion
4 under the leaking.

5 I'm going to be going through the first
6 few slides. And then I'll hand it off to Joey. Next
7 slide.

8 First I'm going to discuss what FFRD is.
9 Then I'll discuss its history. Different experiments
10 have shown that the fuel can fragment during a loss of
11 coolant accident, differences in pressure across the
12 siding can lead to ballooning inverse of the cladding.

13 The fragmented fuel can relocate into the
14 balloon region and first occurs the fragments can
15 disperse into the reactor coolant system.

16 The first image is of FFRD testing that
17 was done at Argonne National Labs at 55 gigawatt days
18 prime to yield. It shows fuel fragmentation
19 occurring.

20 The second image is of the core
21 representation showing that once the fuel fragments,
22 the fragmented pieces relocate into other areas of the
23 fuel such as the balloon region.

24 The third image shows results from a LOCA
25 test at the test facility. And, as you can see the

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1 burst openings can be large enough for the fuel to
2 disperse into the reactor coolant system. Next slide.

3 This slide has the timeline of the
4 history of FFRD. To start, the 50.46 acceptance
5 criteria for LOCAs were created in 1974 when FFRDs
6 were not known phenomena.

7 In 1980 FFRD was discovered during
8 experiments at several test facilities, indicating
9 that irradiated fuel could fragment into small pieces
10 during a LOCA and may relocate actually, settling into
11 the balloon region.

12 In 1984, NRC put FFRD into the generic
13 issue program as GI-92. But, later concluded that
14 known server systems would offset increased
15 regeneration resulting from fuel relocation.

16 It was dropped from the GI Program in
17 1995. In 2006, tests at Argonne National Labs and
18 Spalding indicated that fragmentation and relocation
19 could result in a loss of fuel particles through the
20 rupture opening.

21 In 2008, Rule 08.01 was issued discussing
22 recent hyper analysis research finding, noting that
23 additional research on fuel dispersal was being
24 conducted. This stated that the current 62 gigawatt
25 days for MTU implement is probably slow enough to

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1 prevent significant dispersal.

2 In 2012, NUREG-2121 was issued discussing
3 the knowledge base of FFRD at the time. In 2015,
4 SECY-15-0148 was issued stating that 50.46(b) should
5 not be delayed to include FFRD and that research will
6 continue to be conducted.

7 Future rulemaking may be initiated if
8 necessary. Basically it was believed that there was
9 no imminent safety concern from FFRD up to 62 gigawatt
10 days for MTU.

11 In 2016, the draft final rule for 50.46(b)
12 went out. In 2021, Rule 21.13 was issued. This
13 document is the Office of Research's interpretation of
14 FFRD experimental research to date.

15 In the rule, the staff defines
16 conservative boundaries for FFRD related phenomenon,
17 such as the amount of finely fragmented fuel expected
18 to be dispersed during a LOCA.

19 In 2022, after SECY-2109 was issued by the
20 Commission, directing the staff to address FFRD in the
21 IA rulemaking regulatory basis. And, in 2024, the Lea
22 Hurt conducted on fuel dispersal to help identify
23 further research needs, potential to develop guidance
24 and to help focus NRC staff reviews of applications
25 that may evaluate FFRD. Next slide.

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1 This slide discusses the background and
2 regulatory issue of fuel dispersals. As stated in the
3 timberline on the previous slide, the 50.46 acceptance
4 criteria date back to 1974 when FFRDs were not known
5 phenomenons.

6 Acceptable approaches to demonstrate
7 compliance of the regulations have ensured that
8 catastrophic failure of the rod structure and loss of
9 fuel under configuration are concluded.

10 These approaches include annual
11 assessments to show that peak cladding temperature and
12 maximum local oxidation remain below the limits in
13 50.46.

14 Fuel dispersal would be a departure from
15 precedent, because the fuel bundle geometry would be
16 lost. Fuel dispersal is not -- this will be addressed
17 with the current regulation. Next slide.

18 On the timberline in FROM SECY-2109, the
19 Commission asked staff to include FFRD as part of the
20 increased enrichment rulemaking. Staff has developed
21 five alternatives like different pathways that could
22 be pursued.

23 The five alternatives are not considered
24 mutually exclusive or combinations of elements from
25 multiple alternatives could be considered. Staff has

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1 also considered --

2 MEMBER PETTI: Ashley? This is David.
3 You said mutually exclusive, but the slide says
4 mutually inclusive.

5 Is the slide correct? You can mix and
6 match.

7 MS. SMITH: Yeah, right.

8 MR. MESSINA: Yes, we can mix and match.
9 Yes.

10 MEMBER PETTI: Okay. Good. Thanks.

11 MS. SMITH: Right. Sorry, what I spoke
12 was the opposite of what's on the slide. I understand
13 that.

14 Staff also has been considering other
15 approaches not included in the five alternatives based
16 on public comment.

17 Joey is going to talk about the
18 alternatives on the next slide.

19 MR. MESSINA: Yes. Hi, thank you. I'm
20 Joe Messina. I work in Nuclear Methods and Fuel
21 Analysis Branch. And, I'll go through each of the
22 specific approaches presented in the Reg basis on
23 FFRD.

24 So, the first -- to start off, the first
25 alternative presented, we start with the status quo.

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1 And, we considered maintaining it as one of the
2 licensing pathways.

3 In this alternative, we would keep the
4 current regulatory framework mostly the same, without
5 any major updates. And, continue with the precedent
6 that significant amount of fuel dispersal should not
7 occur.

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

13 It is expected that technical solutions
14 would be needed to prevent high burn of rods from
15 bursting, such as changes in fuel design and/or core
16 design.

17 Use of accident tolerant fuel may also
18 help. For example, coating cladding may limit the
19 balloon size for the first and/or the burst opening
20 size.

21 Additionally, since the regulations do not
22 explicitly speak to fuel dispersal, allowing
23 significant dispersal may not technically require a
24 change to the regulatory framework. But, this would
25 lead to regulatory uncertainty and challenges by both

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1 industry and the NRC.

2 Therefore, pathways that consider
3 significant dispersal are discussed as part of other
4 alternatives. Next slide, please.

5 The second licensing pathway presented
6 rethinks a 50.46(a) style modification of ECCS
7 requirements. For those that are not familiar with
8 50.46(a), it was a final rule that went to the
9 Commission in 2010, that risk informed LOCAs.

10 Specifically, it established a transition
11 break size. For breaks smaller than the transition
12 size, LOCAs would be analyzed as they are today.

13 But, for breaks larger than the transition
14 break size, less conservative assumptions and modeling
15 could be employed, such as allowing for credit of
16 offsite power.

17 In this licensing pathway, LOCAs above the
18 transition break size would essentially be treated as
19 beyond design basis. In beyond design basis action
20 analysis, best estimate modeling and more realistic
21 assumptions can be employed, while during design basis
22 accident analysis a 95/95 is the typical standard for
23 modeling.

24 The uses of beyond design basis modeling
25 may help to show that no rod susceptible to fine

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1 fragmentation and of bursting as a result of a large
2 break LOCA, but it still maybe challenging.
3 Therefore, this pathway could be combined with other
4 pathways presented to analyze the consequences of fuel
5 dispersal.

6 Additionally, there would also be obvious
7 benefits outside of FFRD in the LOCA analysis with
8 this approach, such as increased margin to the peak
9 clad temperature and oxidation limits presented in the
10 current version of 50.46.

11 I'll not that this approach would likely
12 not be a simple cut and paste from the 2010 rule.
13 This would be more of a modernization of the rule.

14 We can update it with any knowledge gained
15 since 2010, or to better capture anything in today's
16 landscape as we see fit. Next slide, please.

17 MEMBER ROBERTS: Hey Joe, a quick
18 question. Has there been any like desktop analysis or
19 estimates as to the may on the previous slide?

20 Whether there's a good chance that the
21 limits will be met with the realistic assumptions?
22 Or, you just don't know?

23 MR. MESSINA: The inspect -- well, since
24 -- are you talking about -- the current limits would
25 be expected to be met, because realistic assumptions,

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1 there would be increased margins.

2 As for any, you know, the core
3 provability, it's -- that would have to be
4 demonstrated.

5 MEMBER ROBERTS: Yeah. Thank you. I was
6 trying to get some feel for what the word may means.
7 Is a may that is done in the calculations?

8 MR. MESSINA: Oh, yeah.

9 MEMBER ROBERTS: Do you think it will get
10 there? Or have you done calculations and think you
11 won't get there?

12 Or, you just don't know?

13 MR. MESSINA: Oh, okay. So, yes. So, our
14 Office of Research actually in August, they presented
15 a paper at NUREG on fuel dispersal calculations for
16 high burn up fuel during a large break LOCA.

17 And, they estimated about 75 percent of
18 the core would burst. Obviously not all that is high
19 burn up rods. So, not all that would be to dispersal.

20 But, the fact that 75 percent of the core
21 would burst, likely indicates that this approach may
22 not be necessary. But, to better understand that, we
23 did ask questions in the FRN and the Reg basis,
24 whether it is feasible to demonstrate that there are
25 no rods, no high burn up rods that burst even with the

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1 best estimate assumptions.

2 MEMBER ROBERTS: Yeah. Okay. Thank you.

3 MEMBER PETTI: So, Joe, You're saying that
4 the NR -- the research staff came up with 75 percent
5 with a best estimate calculation?

6 MR. MESSINA: I believe those were nominal
7 calculations, yes.

8 MEMBER PETTI: Okay. Thanks.

9 MR. MESSINA: Next slide. Okay, yes, this
10 is right. The third licensing pathway proposed in the
11 Reg basis is to provide a safety demonstration of
12 post-fuel dispersal consequences.

13 So, phenomena such as core coolability,
14 re-criticality, and long term cooling would need to be
15 addressed like any other LOCA phenomena. That is to
16 say, that they would need to be modeled with high
17 confidence, you know, to a 95/95 level.

18 As part of this, guidance would be
19 developed regarding analysis of the consequences. We
20 are currently sponsoring a PIRT that Ashley mentioned
21 that is focused on the consequences of fuel dispersal.

22 And, it is expected to be completed
23 sometime early next year. This PIRT would help us to
24 issue guidance with the rule.

25 Though the guidance would have to be

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1 relatively high level and conservative though since
2 there has not been much experimental research on the
3 consequences conducted to date.

4 Though we envision that if this option is
5 chosen, it could -- it could help with determining
6 what experimental research we will do in the long
7 term.

8 And, once we conduct that experimental
9 research in the long term, we can use that to update
10 the initial guidance to be less conservative and more
11 specific once that research is conducted. Next slide,
12 please.

13 The fourth lessons and pathway would be to
14 provide a generic bounding assessment of dose and use
15 risk insights to address post fuel dispersal
16 consequences. Currently there are dose criteria for
17 most for the DBAs, such as control rod ejection
18 accidents, main steam line break.

19 But, for a 50.46 LOCA that is mitigated,
20 where there's, you know, no fuel melting, we assume
21 that the consequences are bounded by the maximum
22 hypothetical accident dose or the MHA LOCA dose, which
23 assumes an unmitigated LOCA that leads to a
24 substantial meltdown of the core.

25 This option would establish a dose

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1 criterion for the LOCA analyzed under 50.46 with fuel
2 dispersal. So, separate from the MHA LOCA dose.

3 Licensees would need to demonstrate the
4 ability to predict a source term for a LOCA with fuel
5 dispersal. Or, be directed to use a fraction of the
6 MHA LOCA source term based on the amount of fuel that
7 is predicted to be dispersed.

8 Regarding the other consequences of fuel
9 dispersal, in this option we postulate that risk
10 incident could be used to address them. For example,
11 insights from operating experience, other regulatory
12 requirements, and industry initiatives could be used.

13 For example, as Elijah had mentioned
14 earlier, severe accident mitigation guidelines, TMI
15 action plan requirements, emergency operating
16 procedures, and as such. Next slide, please.

17 The fifth licensing pathway presented in
18 the Reg basis is to use probabilistic fracture
19 mechanics to show that leaks in large pipes would be
20 identified before failure, including the need to
21 analyze ECCS performance during large break LOCAs.

22 This would be a major departure from
23 current practice. And, would have implications
24 outside of LOCA space as well.

25 This licensing approach builds on industry

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1 initiatives such as EPRI's alternative licensing
2 strategy or ALS that was presented to the ACRS a few
3 months back.

4 This licensing pathway would use XLPR, or
5 the extremely low probability of rupture code that was
6 jointly developed by our Office of Research and EPRI,
7 as well as the LBB concept, or leak before break
8 concept, to show that leaks in large pipes will be
9 able to be detected and operator action will be able
10 to be taken to shut down the reactor with sufficient
11 probability before a pipe breaks and the large break
12 LOCA occurs.

13 If the large break LOCA does not occur, it
14 would prevent any rod failures and thus, any fuel
15 dispersal. This alternative also states that well,
16 since the large break does not occur, then ECCS
17 performance would not need to be analyzed.

18 We acknowledge that this would have major
19 referral effects outside of just the large break LOCA.
20 And, these effects would be examined in more detail as
21 we access each option and decide on a path forward.
22 Next slide, please.

23 MEMBER PETTI: So, Joe, just a question
24 before you go there.

25 MR. MESSINA: Yeah.

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1 MEMBER PETTI: On many of the slides it
2 says this will impact the schedule. But, have you
3 guys looked at it enough to know which ones would
4 impact it more than other alternatives?

5 MR. MESSINA: We have, we don't have like
6 specific numbers yet. That would be determined as we
7 move forward and decide on an option.

8 But, roughly, you know, different options
9 may -- yes, would impact the schedule to different
10 extents.

11 CHAIR BALLINGER: This is Ron Ballinger.
12 As a practical matter, a Licensee could do the
13 increase enrichment, and they already have, by asking
14 for exemptions, right?

15 So, it -- well, which schedule are you
16 actually thinking would be affected?

17 MR. MESSINA: The increased enrichment
18 rulemaking schedule, which the ticketed date is to be,
19 the final Rule June 2026.

20 CHAIR BALLINGER: Oh, okay. So, but it's
21 not really affecting -- it wouldn't necessary effect
22 a licensee wanting to use enrichment beyond 5 percent
23 via exemptions?

24 MR. MESSINA: That is correct.

25 CHAIR BALLINGER: I guess we have

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1 submittals already for exceeding 5 percent that have
2 been approved.

3 MR. MESSINA: Yes. And, we are soliciting
4 industry feedback to help inform, you know, our
5 schedule impacts.

6 But yes, you are correct, there have
7 already been some ones that go above 5 weight percent.
8 And, this would not, you know, this -- they were done
9 before this, so.

10 CHAIR BALLINGER: Got it. Thanks.

11 MR. PEABODY: And, I will say, I mean,
12 I've worked on one of those LARS. This is Charlie
13 Peabody again.

14 We haven't like yet approved it for like
15 an entire batch load. Where you would attend -- like
16 we're still looking at -- we're still looking at like
17 this specific burn up of the test assemblies or any
18 assemblies that are going above this.

19 So, you know, we still have linked to this
20 FFRD issue the 62 as the gigawatt days burn up limit.
21 And, you know, we're still looking at, in terms of all
22 this increased enrichment stuff, we're still looking
23 at how we manage that as well.

24 CHAIR BALLINGER: Well, is it -- am I
25 correct in saying that there's a, there isn't a LAR

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1 that's been submitted or will be for a full batch?

2 MR. PEABODY: I don't think there -- so,
3 I believe they are scheduled to submit LARs for full
4 batches. But, we haven't seen like any justifications
5 for batch loading which would permit burn up beyond
6 the 62 gigawatt days.

7 So, like in theory they could do batch
8 loads and only core -- or only burn assemblies twice
9 instead of thrice. And still stay below that limit.

10 But, you know, like when You're doing an
11 entire batch load, we would expect some fuel
12 assemblies to exceed that 62 gigawatt days limit.
13 And, worse, we still haven't, as a staff, approved
14 that yet.

15 And, there's some hesitancy to approving
16 that without, you know, further studies and
17 justifications as to why it's safe to proceed with
18 that.

19 CHAIR BALLINGER: Thanks.

20 MR. MESSINA: Okay. Next slide, please.
21 So, we provided five lessons in pathways in the Reg
22 basis. But, at this time, we do not provide a
23 recommended pathway, because we feel that stakeholder
24 feedback is important before making a decision on such
25 a complex topic.

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1 We provided six questions to the public in
2 the FRN and the Reg basis on FFRD and the alternatives
3 to better help us make a decision.

4 As we previously stated, these
5 alternatives are not mutually exclusive. We will
6 consider combinations of the alternatives presented
7 for any proposed pathways that were not discussed.

8 I've heard it described as a sample space
9 of options, which I believe is a good description. We
10 provided some projected boundaries of this sample
11 space and we are considering options across the space
12 and may consider options outside of it as well if we
13 get reasonable -- if we are provided reasonable
14 options as part of the public comments.

15 And, I believe that concludes my
16 presentation. This slide I just put there for
17 discussion, to put all the alternatives on one side
18 for ease of questions.

19 MEMBER PETTI: So, Joe, I have a question.
20 I think you guys are going to go out for public
21 comment imminently.

22 And then does -- when does that close and
23 you guys get all the comments back?

24 MR. MESSINA: As of now, the public
25 comment period closes November 22.

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1 MEMBER PETTI: And then, you would come
2 back to us at some point?

3 MR. MESSINA: We would come back to you
4 before the proposed rule goes to the Commission.
5 Right, before Phil?

6 MR. BENAVIDES: Yeah, correct. Sorry,
7 this is Phillip Benavides, the Rulemaking Project
8 Manager.

9 The path forward is a, and as we do with
10 all proposed rules, we get the option for ACRS review
11 as we're going through concurrence prior to the
12 proposed rule being fully approved.

13 MEMBER PETTI: And, what date is that that
14 you have to give it to the Commission?

15 MR. BENAVIDES: The current SECY date is
16 December 2024. So, with that, we'd probably come to
17 you, you know, August or September'ish of next year.

18 MEMBER PETTI: I think it's going to be an
19 issue for the committee to decide. Do we put our
20 input on FFRD and a letter now, or do we wait?

21 CHAIR BALLINGER: Yeah. This is Ron.
22 I've got a path forward that at least the initial
23 discussion for the committee. So, that's part of it.

24 MEMBER PETTI: Yeah. I mean, I'm just,
25 you know, even if we, you know, said oh, we don't like

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1 this option, but we like this option.

2 We could put some guardrails or some
3 criteria around sort of how we would think about the
4 problem, Ron. And, that maybe helpful for the staff
5 at this point.

6 CHAIR BALLINGER: Yeah. I mean, I
7 appreciate that.

8 MEMBER PETTI: You know, if our letter
9 gave you guys some guidance not about what an
10 alternative is, but what's the thought process that we
11 ourselves think you out to think about as you think
12 about the option space.

13 CHAIR BALLINGER: Yeah. Tom has got his
14 hand up.

15 MEMBER ROBERTS: Yeah. Can you go back to
16 the list of options page? It might be easier to ask
17 my question.

18 I was wondering about the application of
19 defense in depth principles. Particularly for option
20 five.

21 Because it seems like the option is solely
22 dependent on predictions from the XLPR code that the
23 large break LOCA won't happen. Which we seem to
24 require revisiting of documents like NUREG-1829, the
25 explanation of break frequencies.

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1 And, comparing that to the EPRI paper,
2 they seem to ask a different question in terms of, you
3 know, is the FFRD during a large break risk
4 significant?

5 As opposed to, is the large break itself
6 risk significant? And so, they talk about defense in
7 depth about things like, containment will be
8 established before the dispersal happens, and that
9 type of thing.

10 And so, they don't go obviously as far as
11 alternative five in terms of what you've go there.
12 But, I was wondering what your thought was on defense
13 in depth and, you know, how sure are you that You're
14 not wrong on the extremely low likelihood of the large
15 break?

16 And, I guess that's my question.

17 MR. MESSINA: Yeah. That's a good point.
18 And, you know, we are, as part of this process, we are
19 assessing, you know, how much we can trust the XLPR
20 code, how much defense in depth is maintained and we
21 find adequate.

22 So, that's all part of the process. And,
23 I can't say, you know, we can't make definitive
24 arguments yet. Or, you know, right now, because we're
25 still assessing it. You know, we'll get public

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1 feedback on this and help us make a firm assessment.

2 MEMBER ROBERTS: Okay. Thank you. So,
3 you think there maybe a, you know, a role for
4 revisiting NUREG-1829 and going back out to a, you
5 know, a different board of experts to see if they
6 would agree with the low likelihood that's predicted
7 by that code?

8 MR. MESSINA: Yes. And NUREG-1829, it was
9 both after elicitation. And, they did do some
10 probabilistic fracture mechanics work.

11 I know Dave Rudland in NRR, he actually
12 wrote a paper, I think, a few years ago, where he used
13 XLPR to compare to the NUREG-1829 LOCA frequencies.

14 And, he said they -- it wasn't wrong to
15 say, it was similar. So, it wasn't drastically
16 different.

17 But, we would obviously still have to
18 evaluate that much more.

19 MEMBER ROBERTS: Yeah. It seems to me
20 that the EPRI recommendation from 2020 might be like
21 a, you talk about these are not mutually exclusive.
22 But, that's kind of like a four and five.

23 It seems like it's a combination of the
24 two of those. I think it fits within what you put out
25 as the five alternatives.

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1 Is that a fair representation?

2 MR. MESSINA: Correct.

3 MEMBER ROBERTS: Okay. Thank you.

4 MR. MESSINA: Yes. Yeah, and we again,
5 you know, I like to think, we tried to capture the
6 boundaries of the sample space. And, alternative five,
7 while based on some, you know, the EPRI ALS is an
8 independent alternative that we developed.

9 CHAIR BALLINGER: Scott Krepel? Your hand
10 is up.

11 MR. KREPEL: Yes, hi. Thank you. This is
12 Scott Krepel speaking through an interpreter of
13 course.

14 The first thing that I wanted to say with
15 regards to XLPR, because that also involved potential
16 development for guidance for what would be
17 appropriately applicable of XLPR and what would it be
18 for individual licensees. So, it's not just, you
19 know, doing a survey of LOCA frequency and so on and
20 so forth.

21 But, anyway, the reason I actually raised
22 my hand is because I wanted to go back to something
23 that was said previously about having higher than a 5
24 weight percent. And, you might remember we did
25 present to the ACRS very recently on the Vogtle LTA.

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1 And, that did have some rods that were
2 above the 5 percent. But, I should add that we just
3 recently, I want to say within the last two weeks or
4 so, received an LAR with regards to spent fuel pool
5 criticality for above 5 percent.

6 But, that Licensee will, you know, still
7 have to submit a separate LAR for actually operating
8 with above 5 percent.

9 Thank you for your time.

10 CHAIR BALLINGER: Well, Elijah Dickson,
11 please.

12 MR. DICKSON: Oh, thank you. Elijah
13 Dickson with the staff. I'd like to point out that
14 alternative four, it does include another layer of
15 defense in depth, because you assume the source term
16 is based off of a full core melt.

17 And so, you are assessing, you know,
18 containment leakage and things of that nature to
19 actually do those, you know, control room and offsite
20 EAB, exclusionary boundary in low population zone
21 calculations.

22 So, we'd be considering, you know, some
23 defense in depth if you did a combination of, you
24 know, for instance alternative four and alternative
25 five.

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1 That's all I have.

2 CHAIR BALLINGER: Thanks.

3 MR. MESSINA: Yes. And, to build up of,
4 I know Scott previously mentioned that XLPR, you know,
5 would not just be used to update the LOCA break
6 frequencies.

7 And, we had some discussions with our
8 XLPR, some of our XLPR experts. And yes, so right now
9 there is a Reg Guide on probabilistic fracture
10 mechanics codes.

11 But, they're not application specific.
12 So, a Reg Guide would be developed as part of
13 alternative five for this application specific use of
14 XLPR as well as any acceptance criteria that goes
15 along with that, with XLPR being used for the
16 application's specific use.

17 CHAIR BALLINGER: This is Ron Ballinger.
18 I do recall actually quite a while ago, there were a
19 number of EPRI projects that produced reports that
20 used probabilistic fracture mechanics to estimate leak
21 rates and times to leak, primary leaks, the effect on
22 CDF.

23 And so, there's been quite a bit done
24 where probabilistic fracture mechanics has been used
25 to analyze breaks.

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1 MR. MESSINA: Yeah. And, in the licensing
2 space though for the most part, XLPR has been -- for
3 licensing space for pipes. It's been primarily used
4 for changes in relief requests for inspection --

5 CHAIR BALLINGER: Right.

6 MR. MESSINA: Inspection frequencies.

7 CHAIR BALLINGER: But, these EPRI projects
8 were pre-XLPR. They were done quite a bit before
9 XLPR.

10 MR. MESSINA: Yes.

11 MEMBER PETTI: So, let me just ask a
12 different question. Because I'm kind of losing a
13 little bit of the discussion, not having been involved
14 in the early days of XLPR.

15 Given that this was a tool co-developed by
16 both NRC research and, I guess, is it EPRI. And,
17 given the alternative licensing approach we heard
18 about from EPRI, this sounds like that they want to
19 use this to reestablish the licensing basis for either
20 a historical plant or a new plant, if there were new
21 light water reactor plant coming in for a license.

22 So, it's not like this little rulemaking
23 is the only one that's going to be bumping up to XLPR.
24 I mean, I'm kind of losing context.

25 It seems like all of a sudden, it's all on

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1 your shoulders. But, this train already left the
2 station when these guys have been working on this for
3 a number of years.

4 So, now we're worried about how good the
5 code is and asking questions? I mean, that train left
6 the track. I'm a little confused.

7 What am I missing?

8 CHAIR BALLINGER: XLPR has been validated
9 any number of ways. It's been quite a while, I think.

10 MEMBER PETTI: Right. And the fact that
11 EPRI came in and said, you know, we're looking at this
12 seriously as an ultimate licensing strategy, if the
13 staff had a problem with it, they should have flown
14 the challenge flag, you know, then, not as we're
15 sitting here talking about, you know, an enrichment
16 regulation that's going to bump up -- that's bumping
17 into this sort of because of FFRD.

18 CHAIR BALLINGER: FFRD is the elephant in
19 the room for the bigger elephant in the room.

20 MEMBER PETTI: So, you know, I'm
21 struggling because I would have expected it, you know,
22 to be the opposite way, right? That there be some
23 sort of regulatory acceptance for XLPR and that whole
24 alternative licensing approach having some foothold
25 before then you start to see sort of some applications

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1 or growth of that as it touches -- you know, as
2 different issues come up. This seems to be -- it's
3 coming in the back door, which doesn't seem right to
4 me.

5 CHAIR BALLINGER: I mean, we're getting a
6 little bit ahead of my -- I don't want to use the word
7 straw man, but discussion in that every folks -- and
8 I use the word every because it could be industry, is
9 planning on a submittal, a formal submittal on ALS in
10 the first quarter of 2024, I think.

11 MR. BLEY: This is Dennis. I'm going to
12 get things a little out of order trying to think back.
13 One of the applications of this went up to the
14 Commission. And my memory was the Commission never
15 voted on it. Can the staff or Ron, can either of you
16 remember about that?

17 CHAIR BALLINGER: Yeah, I don't remember.
18 You know, XLPR was primarily developed to look at
19 primary water stress erosion cracking. I will have to
20 go back and look. I don't know. That's something
21 that we can surely find out.

22 MR. BLEY: Okay. Because that was a big
23 issue for a while. And I don't remember it ever
24 getting word from the Commission. I think it just
25 kind of languished.

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1 MEMBER ROBERTS: Hey, Dennis. This is
2 Tom. I'm wondering if You're thinking about the
3 transition break size ruling, which --

4 MR. BLEY: I must be.

5 CHAIR BALLINGER: Yeah, that was
6 stillborn.

7 MEMBER ROBERTS: This was a question that
8 if you look back in, you know, record safety history,
9 it goes back at least 60 years. And, you know, I
10 stumbled on a 1968 recommendation to not include the
11 large breaks in the design basis, and the AEC staff
12 rejected it because they didn't know enough. It was
13 60 years ago.

14 We have 60 years more knowledge since
15 then, but it seems like as recently as the transition
16 break size discussions, there was an ACRS letter and
17 then there was a -- I think the second they kicked it
18 off, both talk about we need to maintain the large
19 break LOCA for defense-in-depth purposes just to -- if
20 for nothing else, it's always been covered.

21 So it would seem like -- and maybe this
22 XLPR does it, we would have to be pretty confident
23 that after 60 years we really have this nailed and the
24 likelihood of this large break is just that small that
25 we don't need to worry about it.

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1 So, again, that's kind of why I asked the
2 question I did, which is that even as recently as 15
3 years ago, there was a board of experts that concluded
4 there was a reasonable probability of this large
5 break. And that was with consideration of looking for
6 a break and probabilistic fracture mechanics.

7 So I'm certainly not an expert in any of
8 those areas, but it seems like the people who are an
9 expert haven't really lined up behind it at least in
10 the past and, yeah, maybe things have changed to the
11 point that they will.

12 CHAIR BALLINGER: Steve Schultz? I hope.

13 MR. SCHULTZ: Yes, Ron. Thank you. I'm
14 on. Joe, just to comment and then a question. And
15 the question relates to what we were talking about
16 earlier with the opportunity to combine different
17 elements of the alternatives that might be appropriate
18 as the process goes forward.

19 You mentioned that the NUREG paper had
20 nominal assumptions in it. As I looked at the paper,
21 one of the things I noted was that as they evaluated
22 high burnup performance in the typical nominal
23 calculations that they seem to have done to put
24 together a core that would go to high burnup with high
25 enrichment, the steady state evaluation demonstrated

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1 that there were criteria for normal operation of fuel
2 rods that were violated especially at -- or
3 essentially the internal rod pressure, clad liftoff
4 criteria and so forth. And yet they went ahead with
5 the LOCA evaluation given that and in a certain sense
6 thereby increased the rod performance as it came
7 through with regard to the clad cracking and the
8 dispersion of fuel and so forth.

9 The reason I say this in terms of
10 combining different alternatives, one would assume
11 that the fuel design, as you mentioned earlier, fuel
12 design, cladding design, would be really a part of any
13 solution going forward. And that would then combine
14 Alternative 1, Alternative 4 and Alternative 5 as a
15 possibility, the combination of those.

16 MR. MESSINA: Yes. I'm not sure exactly
17 what the question is, but yeah, different alternatives
18 could be, you know, combined. And the study with the
19 NUREG paper, you know, it was just to get a general
20 idea of how much fuel would be disbursed. You know,
21 we've had discussions with Oak Ridge National Lab and
22 other people on, you know, how could we improve what
23 we did in that work.

24 So but, yeah, ultimately clad design and
25 fuel design, you know, could always be changed to

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1 optimize performance for different things and, you
2 know, possibly, you know, help with FFRD so.

3 CHAIR BALLINGER: Well, my comment was
4 that the designers would need to address the steady
5 state fuel operation criteria and limitations before
6 they even address the accident evaluation. But that
7 wasn't a part of the evaluation that was done in the
8 NUREG paper.

9 MR. MESSINA: Yes. They definitely would
10 have to address that.

11 CHAIR BALLINGER: Okay. I guess this is
12 kind of an artificial break between discussion of the
13 presentation and committee discussion because in fact
14 we've been having it for a while.

15 So let me propose -- we now have to have
16 a discussion about path forward. Oops, wait a minute.
17 I'm sorry. Charlie Peabody.

18 MR. PEABODY: Thanks. During the break we
19 were discussing the original question, and I believe
20 Chair Rempe asked about basically the accident
21 tolerant fuels and how, you know, possibly having, you
22 know, fuel cladding with a higher, you know, melting
23 point than the control elements.

24 When we had some more discussions, we kind
25 of believed that we would address that during the like

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1 license amendment phase for a fuel transition and if
2 it was an operating licensee or during the licensing
3 process if it was a new reactor licensee because those
4 are changes to the accident analysis sequence and
5 timing assumptions. So that would be like one we
6 would expect to deal with that not necessarily as part
7 of this rulemaking process.

8 MR. MESSINA: Yeah. The rulemaking
9 process isn't trying to solve every single problem
10 associated with ATF compared to, you know, current
11 field designs. Just, you know, tackle the big issue,
12 the regulatory issues of that.

13 MEMBER REMPE: So this is Joy --

14 CHAIR BALLINGER: Yeah, this goes to Joy's
15 question, right?

16 MEMBER REMPE: Yeah. And this is Joy. I
17 appreciate the additional feedback. I guess, again,
18 I know You're talking about consideration of
19 mitigating strategies in other aspects of this and how
20 that's the source term. So it's good to know that
21 You're not expecting Sandia to include all of this in
22 their updated AST analyses is what I think I'm
23 hearing. You're going to expect the applicants to do
24 this. But I think it might be good to make sure that
25 the applicants are aware of this. Because I don't see

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1 it clearly discussed that You're expecting this under
2 Alternative 4.

3 MR. MESSINA: So this doesn't really --
4 this is kind of outside of the fuel disbursal
5 discussion. This is just purely ATF, you know, the
6 accident timing if someone were to do ATF.

7 MEMBER REMPE: Right. So, again, if you
8 were going to call part of this rulemaking an ATF, it
9 would be good to explain to them that you excluded
10 this from the rulemaking discussion, but it's
11 expected.

12 Again, I'm not sure they get that much
13 extra margin because the margin has decreased with
14 time that we see in some of the more refined analyses.
15 But if they -- you know, it would be good to have that
16 discussed somewhere is all I'm just trying to bring
17 up. That's just why I brought it up at the beginning
18 here.

19 MR. BENAVIDES: Yeah, yeah. I would agree
20 with that. And I think, too, like, a lot of the ATF
21 was originally seen as a precursor to increasing
22 enrichment. But I think that if are looking at
23 increasing enrichment with commercial fuels, I think
24 that you still have, you know, superior efficiency
25 just from an operating standpoint.

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1 I don't know that we'll never get any
2 accident tolerant fuel spills. But we at least
3 haven't been hearing that discussed as much since we
4 actually included the commercial in the rulemaking as
5 well the incident tolerant fuels.

6 MEMBER REMPE: Okay. Thank you.

7 CHAIR BALLINGER: Okay. Going back to
8 these alternatives before we start the discussion, my
9 understanding is that Alternative 5 would basically
10 eliminate fuel failure as a possibility during an
11 accident. And if you eliminate fuel failure, you
12 eliminate disbursal. So the cleanest way to address
13 FFRD is to not have it. That may be a leading
14 question, but is that a correct interpretation?

15 MR. MESSINA: Yes. We feel that the
16 simplest way to address FFRD is to prevent high burnup
17 rod burst. So, yes, under Alternative 5 as well as,
18 you know, Alternative 1 and possibly, you know,
19 Alternative 2, as written, would be to prevent rod
20 burst. Obviously 1 and 2 do it differently than 5,
21 but, yeah.

22 CHAIR BALLINGER: Okay. All right. So
23 let's see. I don't see any more hands up. Now we --

24 MEMBER PETTI: Ron?

25 CHAIR BALLINGER: Yeah, yeah.

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1 MEMBER PETTI: Let me just make sure I
2 understand where you are coming from. What you are
3 saying is that you are somehow risk informing rod
4 burst being precluded based on some risk.

5 CHAIR BALLINGER: Well, I think that's
6 what XLPR in effect does, right?

7 MEMBER PETTI: But even this Alternative
8 2, with a transition break size appropriately modified
9 as Joe said, is kind of the same idea. You are
10 precluding it from the design basis.

11 CHAIR BALLINGER: Right. Yeah.

12 MEMBER PETTI: Right.

13 CHAIR BALLINGER: Yeah, yeah. Yeah.
14 Okay. So now for my straw man or path forward, I
15 would think that we would write a letter on this
16 topic. And then according to the staff, the input on
17 FFRD will come, and they will incorporate those
18 comments into the proposed rule, which we would get a
19 crack at either before or after public comment.
20 That's up to the committee.

21 In the meantime -- Joy's got her hand up,
22 of course. In the meantime, the EPRI folks will be
23 submitting the ALS process formally, supposedly in the
24 first quarter. And so we will have the advantage of
25 being able to either review that or have a

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1 presentation or at some point some way to take a look
2 at that ALS in detail because we've had presentations
3 that discuss ALS, but they have been mostly part and
4 parcel of a larger presentation.

5 So that would be a proposal for going
6 forward. And I'm sure Joy has an opinion.

7 CHAIR REMPE: Actually, my hand is up not
8 for that. I think this discussion about whether we
9 should write a letter or not might be best after
10 public comment. What do you think? Just because I
11 think that it's --

12 CHAIR BALLINGER: Well, here's --

13 CHAIR REMPE: It's just up to you. It's
14 just a suggestion.

15 CHAIR BALLINGER: No, no, no. It's not up
16 to me. It's up to the committee as a whole.
17 subcommittee and the committee as a whole.

18 If that were to happen, then we would not
19 write a letter on this right now. But we wouldn't --
20 that letter would not occur until probably the middle
21 of next year when we would get the rule language if
22 I'm looking at the schedule correctly. That has, by
23 the way, the advantage of --

24 MEMBER PETTI: Ron, Ron, I think you
25 misunderstand Joy. She might be --

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1 (Simultaneous speaking.)

2 CHAIR BALLINGER: I am definitely prone to
3 misunderstanding.

4 MEMBER PETTI: I want you to go out to
5 public comment first and then we go to, you know, our
6 next steps.

7 CHAIR BALLINGER: Yeah. So that would
8 mean that public comments, the one that they're -- the
9 public comments that they're expecting are related to
10 FFRD.

11 MEMBER REMPE: No, I'm saying public
12 comments for this subcommittee meeting. And then
13 let's have a larger discussion --

14 CHAIR BALLINGER: Oh, I'm sorry.

15 MEMBER REMPE: -- and then proceed
16 providing input.

17 CHAIR BALLINGER: All right. I am prone
18 to --

19 (Simultaneous speaking.)

20 MEMBER REMPE: Dave and I are talking the
21 same way but, yeah, You're -- anyway. It's up to you.
22 You're the subcommittee chair, but --

23 CHAIR BALLINGER: Hit the rewind button.
24 It's time to go out for public comments. There are
25 100 people on this call. Are there any members of the

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1 public that would like to make a comment? If you
2 would like to make a comment, please state your name
3 and make your comment. And the numbers keep going up.
4 Ed Lyman?

5 MR. LYMAN: Yes, hi. It's Ed Lyman from
6 the Union of Concerned Scientists. Can you hear me?

7 CHAIR BALLINGER: Yes.

8 MR. LYMAN: Yes. Thank you for the
9 opportunity. I would just like to say, you know,
10 walking down memory lane, I think most people realize
11 this is not a new issue. In the 2005 time frame, we
12 looked at it in the context of MOX fuel because there
13 was -- Duke Energy had applied for an OTA application
14 for MOX fuel test assemblies. There was an issue with
15 potential vulnerability of MOX fuel to high burnup
16 effects, even at lower burnup, including FFRD.

17 IRSN at the time was coming to the NRC and
18 pleading for help in research funding to look at that
19 issue as well as the impact of things like ballooning
20 of multiple fuel rods and three dimensions on heat
21 transfer and core coolability.

22 I don't think any of that work was ever
23 done experimentally. The funding never came through.
24 And so here we are, you know, almost 20 years later
25 with a missed opportunity to possibly have more

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1 informed discussions about that.

2 So long story short, we don't think that
3 there is a technical basis for any option that would
4 essentially wave a risk magic wand and make this issue
5 go away. In fact, it's time that the Commission fully
6 confront the safety issues associated with high burnup
7 fuel and not continue to kick that can down the road.

8 So I don't want to jump the gun on our
9 comments, but I don't think any solution that would
10 essentially remove analysis of this potentially
11 significant safety issue from the design basis would
12 be appropriate. This is a design basis issue. This
13 is a fundamental safety requirement for nuclear power
14 plants is that they can survive a loss of cooling --
15 a design basis loss of cooling accident without, you
16 know, the excessive fuel damage that would potentially
17 lead to a propagation of the accident and a full scale
18 core melt.

19 So, again, we are concerned about these
20 efforts such as Alternative 5 and even Alternative 2
21 to try to just make the issue go away without having
22 to confront it. And that's the sort of preview of
23 what our comments are going to be.

24 One other thing, with regard to Dr.
25 Rempe's observation about the melting of the control

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1 rods before the fuel, I didn't hear a really good
2 response to that.

3 And I would think that -- this rulemaking
4 is an opportunity to look at sort of the broader --
5 some of the broader issues associated with higher
6 enrichment fuel safety issues that might include some
7 additional accident analysis that might envelope
8 considerations such as what Dr. Rempe brought up.
9 Also I want to point out that these -- as you approach
10 10 percent, the void coefficient and the WR starts
11 approaching zero. And that could be a synergistic
12 effect with other impact summary activity in a severe
13 accident.

14 So it seems like there is a wealth of
15 other issues that should probably be encompassed in
16 this rulemaking, especially if the original basis for
17 accident tolerant fuel seems to be going by the
18 wayside that was actually making reactors safer.
19 Instead, we're getting bait and switch that the main
20 basis for the research money that the Department of
21 Energy put into accident tolerant fuel is now being
22 redirected or misdirected toward simply allowing
23 increased enrichment and increased burnup for economic
24 reasons without any common safety benefit.

25 So there were a lot of serious issues here

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1 that I think should all be considered in the
2 rulemaking discussion and the package and the
3 associated analysis. That's my comment. Thank you.

4 CHAIR BALLINGER: Thank you. Excuse me.
5 Whoops. Donna Gilmore, please.

6 MS. GILMORE: Can you hear me?

7 CHAIR BALLINGER: Yes, I can.

8 MS. GILMORE: Okay. Thank you. I don't
9 see any mention of an evaluation of the metal hydrides
10 created, you know, during the reactor process. The
11 zirconium hydrides, the uranium hydrides, plutonium
12 hydrides, none of that is addressed.

13 Dana Powers years ago said the NRC has
14 ignored the metal hydride issue which can cause
15 explosions of basically at any temperature. So I
16 would like to know if that is being addressed.

17 We're sitting here at the current plants,
18 like at San Onofre, we have this fuel that impacts
19 hydrides. We've got damaged hydrides or damaged fuel.
20 We've got fragile fuel because, you know, the fuel is
21 thinner, the fuel rods. You know, the uranium pellets
22 are becoming less dense. You know the zirconium is
23 becoming thinner. You know about the radial hydrides.
24 We're not even at the LOCA period. We're just at the
25 period of how damaging the high burnup fuel is right

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1 now and yet we're just trying to jump to higher.

2 Are those issues going to be covered in
3 this rulemaking or NORD? To me this is a major issue.
4 I am concerned that if air gets into these canisters
5 if we're going to be faced with explosions because of
6 these metal hydrides and now we're just talking about
7 just making the problem worse.

8 And my second question/comment is with
9 higher enrichments, you know, there's a normal amount
10 of radiation that's released by normally operating
11 reactors into the environment. You know, what kind of
12 percentage increase are we going to get being released
13 out into the environment from reactors with these
14 higher burnups? Is that addressed anywhere?

15 Those are my two comments/questions.

16 CHAIR BALLINGER: Thank you. Next in line
17 is Paul Clifford.

18 MR. CLIFFORD: Yes. Good afternoon. So
19 several of the fuel disbursement alternatives involve
20 rulemaking, presumably including 5046.

21 If the staff were to propose or recommend
22 one of these alternatives that involve rulemaking,
23 would those changes be relative to the existing
24 regulation or would they be relative to the proposed
25 final 50.46c?

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1 I ask because there are portions of 50.46c
2 that are still relevant. The rule could be improved
3 upon to make it more technology neutral and more
4 performance based. And there is an opportunity to
5 combine these changes with the increased enrichment
6 changes that are being discussed today and that there
7 could be really an opportunity for synergy with the
8 implementation of both in a coincident fashion.

9 CHAIR BALLINGER: Thank you. Next, Kalene
10 Walker.

11 MS. WALKER: Hello. So I live in a
12 reactor community where there is stranded spent fuel
13 waste storage. And because of this I have really
14 studied the canister systems and the susceptibility to
15 cracking, corrosion cracking, and also the concerns
16 about the fuel, the high burnup fuel and the condition
17 of the fuel, the hydrides and all of the problems with
18 fuel cladding that the previous caller spoke on, which
19 the NRC seems to kind of ignore, you know, even saying
20 that the canisters are safe to transport when they
21 don't even have a way to inspect one canister or the
22 fuel within it.

23 So when I started listening in on these
24 new reactor fuels and higher burnups and everything,
25 and I heard about fuel fragmentation relocation

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1 distribution from a LOCA, I was kind of appalled and
2 shocked because I saw these higher burnups turning the
3 fuel pellets into dust, you know, small particles and
4 dust.

5 So my question is, how in the world would
6 you take -- and broken, damaged fuel. How in the
7 world would you handle damaged fuel where the fuel has
8 become, you know, small particles? Are you going to
9 put that into a pool? Are you going to take -- who is
10 looking at the back end of this? You know that there
11 is going to be a huge problem in the reactors if there
12 is a loss of cooling.

13 But then we have this forever waste that,
14 you know, these reactors create. And I keep looking
15 for Part 72 and all these NUREGs. And they just say,
16 oh, it will just be managed like the previous fuel,
17 you know.

18 And, you know, the only answer I have
19 gotten from the NRC is, oh, we're very early in the
20 process. Well, it doesn't sound like it. It sounds
21 like you are going to be allowing this through
22 exemption to be putting higher enriched fuel, you
23 know, into existing reactors before you start putting
24 in small modular reactors.

25 I mean, at some point, I think the NRC and

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1 the ACRS needs to say this is not a good plan. This
2 is not a good path forward regardless of the financial
3 benefit for the industry. But I am very curious when
4 Part 72 will be addressed. Thank you.

5 CHAIR BALLINGER: Thank you. Okay. I
6 want to be sure that we don't miss somebody. Donna
7 Gilmore, your hand is still up. Is that a mistake?

8 MS. GILMORE: Yeah, that was a mistake.

9 CHAIR BALLINGER: Okay. Also again,
10 Kalene Walker, your hand is still up.

11 MS. WALKER: I'm trying to lower it.

12 CHAIR BALLINGER: Okay. Thank you. Okay.
13 I don't know, but are there any other members of the
14 public that are on the line that are not on our list
15 here that would like to make a comment? If there are,
16 please state your name and make your comment.

17 Hearing none, okay, now I think we are re-
18 centered a bit. Now additional discussion among the
19 members. What I have -- my initial thoughts were to
20 write a letter on this and then write a second letter
21 or more after we get the rule, and which would include
22 the comments on FFRD, which are not in this -- not
23 incorporated into this current revision.

24 But Dave has had a different thought,
25 which is to say wait until we get the public comments

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1 and do the rule. Is that what I'm hearing, Dave?

2 MEMBER PETTI: No, no. What I'm saying is

3 --

4 CHAIR BALLINGER: Okay.

5 MEMBER PETTI: -- is now is there
6 something that we can help the process by providing
7 not necessarily detail on, you know, which alternative
8 we like, but what criteria? How would we think about
9 the problem? What are the important things to be
10 considered because you have to balance, we've heard --
11 you know, it's a classic case of defense-in-depth
12 versus risk informing. And how do you strike that
13 balance? And, you know, are there words of wisdom
14 that we can give the staff as they think about it?

15 CHAIR BALLINGER: So You're saying that
16 that would be in the form of a letter on this topic,
17 on this document?

18 MEMBER PETTI: Yeah, yeah.

19 CHAIR BALLINGER: Okay. So a letter on
20 this document, and then we would out of necessity have
21 to have -- want to do a letter once we get the rule,
22 which will incorporate the FFRD input, and we would
23 have the benefit -- we will have the benefit of the
24 ALS discussion that we would have with the EPRI folks
25 based on their submittal.

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1 But what Dave is proposing is quite a
2 different letter, which is great actually.

3 MEMBER PETTI: I just wonder, what do the
4 other members think?

5 CHAIR BALLINGER: Yeah, that is what I was
6 about to say. We don't have -- we have Bob. We have
7 Den -- well --

8 MEMBER MARTIN: Yeah, this is Bob. I am
9 absolutely in support of providing a letter sooner
10 than later. In some ways my impression from the
11 presentation is, you know, it just kind of scratches
12 the surface for what it might touch. And I think, you
13 know, us getting together and, you know, pooling our
14 thoughts, I think we could really add value to the
15 process. So I'm with Dave there on moving forward,
16 you know, early in this process.

17 CHAIR BALLINGER: Okay. Let's see. I
18 would suggest then that if we're going to have that
19 kind of letter that we have a more formal structured
20 discussion before we do the letter than just having a
21 discussion here because it's a new thought, and it's
22 a pretty significant thought. What do members think?

23 We have plenty of time apparently because
24 we're not expecting anything related to the rulemaking
25 until the end of next year or middle of next year.

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1 MEMBER MARTIN: Yeah, I would think we
2 would want to cover this in the full committee. I
3 don't know what our schedule is offhand for November.
4 But I think --

5 MEMBER REMPE: So this is --

6 MEMBER MARTIN: -- go ahead.

7 MEMBER REMPE: I'm sorry. I thought you
8 were done, and I was going to provide input on the
9 schedule for November. We have two letters scheduled.
10 And the first one will be on the Level 3 EPRA, and the
11 second one that was scheduled was this one. Because
12 of the timing and all of that, it would start -- the
13 discussion would start on the second in the morning.

14 I'm not sure I understand what Ron is
15 saying about having a more structured discussion.
16 Does that mean you want staff to not come back with
17 the whole review of all of what's in the regulatory
18 basis document? Are you thinking you would like to
19 delay it a month or so, Ron? But it's fine. We can
20 do that.

21 CHAIR BALLINGER: No. What I'm thinking
22 about is we have -- because I assume that we were
23 going to do a sort of, I call it, a standard letter,
24 we have time allotted during full committee. But we
25 could ask -- because we're talking about a full

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1 committee discussion, we could ask the staff to give
2 that presentation in November because it's already
3 scheduled, but have the discussion a little bit
4 different because now You're addressing the topic to
5 the full committee followed by a discussion which is
6 in much more detail and a little bit different than I
7 had originally anticipated to be pretty much focused
8 on fuel disbursal.

9 So we could use that time to bring the
10 full committee up to date because there are a number
11 of members that are not here, I don't see, that would
12 be -- whose input would be, I'm sure, quite valuable.

13 So that would be a thought on how to
14 proceed, and it doesn't short change anybody.

15 MEMBER ROBERTS: I might have a slight
16 different view than Dave and Bob. And Ron said we
17 were going to get a presentation from EPRI sometime in
18 the first quarter or 2024. And they are going to give
19 us their view of the balance of risk informing versus
20 defense-in-depth. And I think there are pieces of
21 both because defense-in-depth are risk informing
22 includes a defense-in-depth component.

23 And so if we're going to give advice to
24 the staff on how we would approach this, then we might
25 benefit from hearing EPRI's view in more detail than

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1 getting the white paper from a couple years ago. And
2 it may help, if nothing else, kind of crystallize what
3 our view is or at least what we think the issues are.

4 So there's no great hurry to send a letter
5 back. There may be benefit to scheduling the letter
6 to follow that EPRI presentation.

7 CHAIR BALLINGER: Yeah. You know, there
8 is another piece to this and that is -- I'm pretty
9 sure the EPRI people are listening to this discussion
10 -- that our discussion that we've had thus far might
11 help steer or inform the meeting that we would have on
12 ALS when they do their submittal because what Tom is
13 saying is that, you know, this is much broader than
14 FFRD. What do people think about that?

15 MEMBER PETTI: That's a little chicken and
16 egg, right?

17 CHAIR BALLINGER: Well, I don't know if
18 it's chicken or egg. It's just the detailed
19 discussion of ALS that's on the record would be quite
20 informative.

21 MEMBER PETTI: Yeah, no, I'm just saying,
22 you know, who is informing who? Tom would like us to
23 wait until we hear on that in an actual submittal so
24 we can be informed. But then you were sort of
25 implying, well, EPRI's on the line. And if we put

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1 that information out, it may inform them.

2 CHAIR BALLINGER: No, I guess, what I was
3 saying was that a lot of the comments that Tom has
4 made related to defense-in-depth and the like might
5 inform in some respects the ALS discussion. More
6 comments? We need to have at least some kind of path
7 forward anyway.

8 MS. ABDULLAHI: Ron?

9 CHAIR BALLINGER: Yes?

10 MS. ABDULLAHI: Can you ask the staff what
11 they want? Because I was under the impression that
12 they asked for a letter, but it's better to ask them
13 instead of me speak for them.

14 CHAIR BALLINGER: Yeah, I kind of react
15 negatively to that because it's really up to us in the
16 end. What do other members think?

17 MEMBER MARTIN: This is Bob. I hate to
18 throw out a compromise, but we can have a letter now
19 and a letter later, right? There is nothing that
20 precludes we get more information and, you know, I
21 think, you know, with more information we'd have a
22 different message.

23 You know one of the things about waiting
24 is I would be very curious about what the pertinent
25 sites carry. But I do think there are -- you know,

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1 prior to public comment, there are messages or
2 recommendations that we might be able to vet out of,
3 you know, our next month discussion that might be
4 worthwhile. And if the staff is interested, I think
5 I support the staff.

6 CHAIR BALLINGER: So let me try to put
7 what people are saying in words that I understand. So
8 as I think I've alluded to, we have a presentation by
9 the staff in November. But based on that discussion
10 -- after that presentation, the committee as a whole
11 has a more detailed discussion amongst themselves.
12 And then the letter that we produce follows that.

13 In other words, it's not a letter that we
14 would have a draft ready for full committee in
15 November. It would be a letter that we would produce
16 for say the following month's full committee that
17 would have the tone that Dave has suggested, among
18 other things. Is that what I'm hearing?

19 MEMBER REMPE: So this is Joy, and I would
20 not be so absolute that it has to wait until next
21 month. First of all, we have often said interim
22 letter, and we know that staff hasn't decided what
23 they are going to do about FFRD yet. So clearly this
24 would be that type of interim letter that will get
25 more informed as things move forward.

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1 I strongly support what Dave has suggested
2 about framing the issue and getting some guardrails,
3 I think is the word he used during the discussion. I
4 do not support having a letter that talks about every
5 topic and regurgitates what is in the 200 page
6 regulatory basis document. You know, so I don't think
7 we should have to spend time on letter writing on
8 that. But maybe have this discussion and come up with
9 some key points after the staff gives a truncated
10 presentation of what they went through today.

11 And, you know, maybe Dave and you can work
12 up some preliminary thoughts for guardrails and then
13 bounce it off of the committee during that discussion
14 time.

15 CHAIR BALLINGER: That's a --

16 MEMBER REMPE: We have two letters we're
17 doing in November so we can go back and forth. And
18 that would be on the second day, Thursday of the
19 meeting, during November. And we do have Friday. So
20 we could come close to finishing the letter this
21 month. And then if it does get delayed, it gets
22 delayed and finish it up the next month.

23 But we do have two letters scheduled for
24 December and, you know, saying I'm going to wait and
25 not finish the letter until December, that would

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1 create other difficulties because of other things that
2 occur before the full committee meeting in December.
3 Okay? Dead silence.

4 CHAIR BALLINGER: No. I'm trying to make
5 sure that I have things clear in my head.

6 MEMBER PETTI: No, I think that's okay.
7 I mean, Bob clearly has some perspective, Bob and Tom
8 have perspective here.

9 CHAIR BALLINGER: Yeah.

10 MEMBER PETTI: If we could kind of put
11 some thoughts together in preparation for -- what's
12 going to help the full committee is that people have
13 some of these thoughts, you know, ahead of time we'll
14 put the paper so we don't have to do that at the full
15 committee.

16 CHAIR BALLINGER: Okay.

17 MEMBER PETTI: We just have to kind of
18 assemble it, right, and synthesize it. But if
19 everybody would -- what I call guardrails, sort of
20 what are the key things you are going to think about
21 in terms of, you know, a success path, if you will,
22 you know, through this option space?

23 CHAIR BALLINGER: Okay. So --

24 MEMBER PETTI: What are the considerations
25 that are important.

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1 CHAIR BALLINGER: So --

2 MEMBER PETTI: That's what I would want to
3 do.

4 CHAIR BALLINGER: Okay. What I'm hearing
5 then is that for the discussion at the full committee,
6 we would put what amounts to an outline together that
7 we would present for discussion at the full committee
8 to basically guide the discussion. And then based on
9 the feedback from the members on that outline, then we
10 would produce a letter. Now I'm hearing silence.

11 MEMBER REMPE: I think that's great. And
12 I do agree that Bob and Tom should also contribute.
13 I just was saying get a small group and have some
14 thoughts ahead of time.

15 I do think we don't want as long of a
16 presentation. But maybe if the staff could give --
17 realizing that the letter is going to be not -- it has
18 a different purpose than perhaps what they thought and
19 maybe give a very small truncated presentation because
20 it's full committee and a different audience.

21 CHAIR BALLINGER: Yeah, here is another
22 thought that I might add. If we can put this outline
23 together quickly, reasonably quickly, certainly before
24 the -- in time to let the staff see it, that might
25 inform their presentation. Maybe we just don't have

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1 enough time to do that.

2 MEMBER PETTI: Yeah, I worry about that.
3 I'm pretty busy next week.

4 MS. ABDULLAHI: We don't have to worry
5 about the FACA. I don't really know that we can give
6 an advance.

7 CHAIR BALLINGER: Okay. All right. Gosh.
8 Okay. All right.

9 MEMBER PETTI: But I also think, you know,
10 who is -- we have, what, two or three members that
11 aren't here, right?

12 CHAIR BALLINGER: Yeah, I know, that's the
13 reason why this full committee discussion is
14 important. Greg is not on here. And do I see Matt?
15 There is 98 people on this thing.

16 MEMBER SUNSERI: Matt is on. Matt is on.

17 MEMBER REMPE: Vicki, I'm not sure if
18 Vicki --

19 CHAIR BALLINGER: Okay. So Matt is on.
20 That's important.

21 MEMBER PETTI: I don't think Vicki is on.
22 Is Vesna?

23 MEMBER REMPE: Walt is in France.

24 CHAIR BALLINGER: Yeah, she's on.

25 MEMBER PETTI: Okay. And then Walt, Walt

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1 is in France.

2 CHAIR BALLINGER: Yeah, and those are --
3 that's got to be important input.

4 MEMBER PETTI: Right. That's why I'm
5 saying they need to -- they probably need to hear 75
6 percent of the sides. Oh, there's Vicki. Vicki's on.

7 MEMBER BIER: Vicki is here. But I'm at
8 an airport so I've been following with some
9 difficulty.

10 CHAIR BALLINGER: Okay.

11 MEMBER PETTI: Yeah, so I think it, you
12 know, not -- you know, in the past when we've told the
13 staff high level summary, it's because we've all been
14 in the room at subcommittee. We want fewer slides,
15 but that may still be 75 percent of what you've got
16 because we've got members who were not here.

17 CHAIR BALLINGER: Now I'm asking how much
18 time did we allot for the staff for November? I don't
19 have that information.

20 MEMBER PETTI: It's probably two hours,
21 right, the usual?

22 CHAIR BALLINGER: Yeah, Larry is --

23 MEMBER REMPE: I'm pulling up the agenda.
24 Larry is not here, but I signed off on it. And I'm
25 looking here, quickly.

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1 CHAIR BALLINGER: Yeah, Larry is sitting
2 on a beach.

3 MEMBER REMPE: We have 8:30 to 10:30. But
4 because the discussion is going to be a lot more
5 important, we had 10:30 to 11:30 or after 10:30 for
6 the committee deliberations. But I would suggest you
7 try and limit it to an hour, an hour and a half, Ron.
8 But, again, that's just a suggestion to keep people
9 focused.

10 CHAIR BALLINGER: Now are you saying an
11 hour, an hour and a half for their presentation or the
12 total?

13 MEMBER REMPE: The agenda allocated two
14 hours for the presentation and questions from the
15 committee. If I were you, I would suggest that the
16 presentation be abbreviated and not take the full two
17 hours because I think --

18 CHAIR BALLINGER: Oh, yeah. Okay.

19 MEMBER REMPE: -- that the discussion is
20 going to be more important for getting this letter.

21 CHAIR BALLINGER: So if we were to ask the
22 staff to limit it to an hour, then we have another
23 hour. And could we add another half hour onto that
24 just for --

25 MEMBER REMPE: Oh, you have -- again, we

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1 have a very open and flexible agenda. But after that,
2 I already have given you an hour to an hour and a half
3 for discussion for the letter.

4 CHAIR BALLINGER: Okay. All right.

5 MEMBER REMPE: But you can have two and a
6 half or if you want less time --

7 CHAIR BALLINGER: Okay.

8 MEMBER REMPE: -- we can do lunch early
9 and come back.

10 CHAIR BALLINGER: Okay.

11 MEMBER REMPE: You know, there's a lot of
12 flexibility.

13 CHAIR BALLINGER: Okay. I think we're
14 getting a little bit of convergence here.

15 MEMBER PETTI: So --

16 CHAIR BALLINGER: So I'm getting -- Dave?

17 MEMBER PETTI: So, no, I'm just saying, if
18 it's allowed, and I need people to tell me, I would be
19 happy to be the collator of people's thoughts and put
20 it together so that it will just help the focus of the
21 meeting in full committee.

22 MR. MOORE: So this is Scott Moore.

23 MEMBER PETTI: Can we -- do you have --

24 MR. MOORE: Yeah, this is Scott Moore.

25 Can you hear me, Dave?

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1 MEMBER PETTI: Yeah.

2 MR. MOORE: Okay. So what the committee
3 members can do is -- the committee members can
4 provide, you know, one member input so they can
5 collate it and put together something. Once that's,
6 you know, assembled, then that would need to be
7 discussed in a public meeting.

8 MEMBER PETTI: Right, right. Okay. Well,
9 I'll volunteer, Ron. You get the boilerplate, and we
10 have to say something about the other parts of the
11 rulemaking. Not that we have to spend a lot of time
12 on it, but we need to at least say whether we agree
13 with, for instance, their recommended approaches on
14 the other side.

15 CHAIR BALLINGER: Yeah, that's, you know,
16 what I'm -- okay, I suppose.

17 MEMBER PETTI: And I'll take the input
18 from the other guys and that will be the start of the
19 last piece, the FFRD.

20 CHAIR BALLINGER: What I'm suggesting is
21 that we don't produce a letter in November because we
22 have to have the committee of the whole discussion,
23 which is a little bit different. What You're saying
24 is --

25 MEMBER PETTI: Let's try. We're going to

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1 need that. We still need all that stuff that we
2 always have in the beginning of the letters, you know?
3 That all still has to be there. And I think we do
4 want to say whether we agree or disagree with the
5 other parts of the rulemaking. The other pieces that
6 it touches.

7 CHAIR BALLINGER: Yeah.

8 MEMBER PETTI: Because that just --

9 CHAIR BALLINGER: Okay.

10 MEMBER PETTI: -- and that's the reason.

11 I agree with the ones -- the recommended actions. I
12 think we just want to be on record with that.

13 CHAIR BALLINGER: Yeah, okay.

14 MEMBER PETTI: And then this one, you
15 know, it takes a little bit more. It will be really
16 the guts, the important, the meat of the letter. But
17 that will at least focus us.

18 MEMBER REMPE: This is Joy. And --

19 MEMBER DIMITRIJEVIC: So we are still
20 having --

21 MEMBER REMPE: We have two letters -- real
22 quick, Vesna. We have two letters in December. They
23 are already scheduled, and you are the lead on one of
24 the other letters in December. So let's try --

25 MEMBER PETTI: Yes.

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1 MEMBER REMPE: -- if it goes on, it goes
2 on. Go ahead, Vesna. I apologize for interrupting.

3 MEMBER DIMITRIJEVIC: That's what I was
4 sort of like trying to decide. Are we discussing now
5 are we going to write a letter or not write a letter
6 or not write a letter in November or how are we going
7 to write a letter? That's what --

8 MEMBER PETTI: I think we should try to
9 write the letter and try to get --

10 MEMBER DIMITRIJEVIC: Maybe we should know
11 more on that day. If it's just how you run things,
12 we shouldn't, you think we should make --

13 CHAIR BALLINGER: I'm thinking that if we
14 want to take the path that Dave is suggesting in terms
15 of providing guardrails as he has mentioned and things
16 like that, then that requires a much more extensive
17 discussion before that piece goes into the letter.
18 And I suggested that we have an outline for at least
19 that part for November for the full committee
20 discussion. I have no problem providing a letter, but
21 I'm thinking a letter that just agreed with what their
22 suggestions are is a different letter. You know, the
23 --

24 MEMBER PETTI: No, no, I'm saying that
25 will all be the beginning of the letter. And then

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1 there will be this final section, which is what we'll
2 focus most on in full committee. I'll have --

3 CHAIR BALLINGER: Okay.

4 MEMBER PETTI: -- received input from
5 people. I'll assemble it, put it in context. And
6 that's how we'll -- you know, we'll go from there.

7 And hopefully, I think -- because I think
8 the stuff that You're going to put in is going to be
9 pretty non-controversial. We can see --

10 CHAIR BALLINGER: Okay.

11 MEMBER PETTI: -- all of that and just
12 focus on this.

13 CHAIR BALLINGER: Yeah, the plan I had in
14 the original letter was to just say by the way, the
15 document is not considered FFRD. And that's for
16 future -- you know, that's going to happen in the
17 future, but it's important.

18 And so instead of that, we would put a
19 much more detailed discussion of what you keep -- you
20 term guardrails and the like. That's fine. But what
21 I'm saying is I don't think we should constrict --
22 maybe there's enough time. Maybe there's plenty of
23 time, and it's no big deal.

24 But I don't think going in we should
25 constrain ourselves to have something finished as a

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1 letter in November because we might have input from
2 other members, which are different thoughts, which are
3 valuable input, which we have to digest and to cram --
4 you know, to go back to the hotel at 2 o'clock in the
5 morning and come up with input to me just seems like
6 going a little too fast if that's what comes up.

7 MEMBER MARTIN: I agree, Ron. I think we
8 should commit to doing the best we can with the time
9 available. And we can't foresee what others might
10 think that are not here.

11 CHAIR BALLINGER: There's nothing to
12 prevent us from having a draft letter done in November
13 and having it spill over into December, I don't think.

14 MEMBER REMPE: I agree with what You're
15 saying, Ron. I just think we should try and if it
16 doesn't work, it doesn't work.

17 CHAIR BALLINGER: Try is one thing. But
18 try under penalty of death is another thing. Okay.
19 So I'll produce boilerplate and letter and that kind
20 of stuff, Zena and I will.

21 And Dave will assemble input from folks,
22 which by the way might end up including input based on
23 -- input from member that aren't even here based on
24 the discussion at the full committee meeting and then
25 we'll go from there. What do people think?

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1 MR. BLEY: Oh, for God's sake.

2 CHAIR BALLINGER: Who is for God's sake?

3 MEMBER PETTI: She just asked, you need to
4 get votes from the members, Ron, to go around and ask.

5 CHAIR BALLINGER: Yeah, I was kind of
6 hoping I would get more comments, but.

7 MEMBER PETTI: Yeah.

8 CHAIR BALLINGER: Okay. Well, I'll go
9 around the room. Bob, what do you think?

10 MEMBER MARTIN: It sounds good to me.

11 CHAIR BALLINGER: I'm just trying to go
12 exactly -- I don't need to know what Dave is sending.

13 MEMBER SUNSERI: Matt's okay with the
14 plan.

15 CHAIR BALLINGER: Okay. That's Matt.
16 Joy?

17 MEMBER REMPE: The plan sounds good to me.
18 Thanks.

19 CHAIR BALLINGER: Matt we already have.

20 MEMBER BIER: This is Vicki, Ron.

21 CHAIR BALLINGER: Yeah, yeah. Okay. I'm
22 not down to the V's yet.

23 MEMBER BIER: Okay. You want to wait? I
24 can wait.

25 CHAIR BALLINGER: No, no, I was kidding.

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1 Go ahead.

2 MEMBER BIER: Okay. I just wanted to say
3 I like the idea of starting in November and going into
4 December if need be. It makes sense to me.

5 CHAIR BALLINGER: Okay. Tom?

6 MEMBER ROBERTS: Yeah, I agree with the
7 try. I think we need to find out what Dave can
8 compile from those of us who probably have different
9 views on this and see how coherent it is before
10 committing to November or even December. So I'm okay
11 with trying.

12 CHAIR BALLINGER: Okay. Vesna?

13 MEMBER DIMITRIJEVIC: I think that this is
14 -- I mean, a good idea to see what can come from the,
15 you know, from Dave compiling the others' opinions.
16 There is no -- I don't know. I mean, you know, in the
17 general, I'm not for writing letters which don't say
18 too much. I mean, that's it.

19 CHAIR BALLINGER: Well, this letter would
20 say quite a bit actually.

21 MEMBER DIMITRIJEVIC: All right. Okay.
22 Well in that case, you may need the more time. So, I
23 mean, you know.

24 CHAIR BALLINGER: Have I missed anybody?

25 MEMBER MARCH-LEUBA: Yeah, in my opinion,

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1 let's go for a letter. Too constrained, December is
2 busy so let's try to finish in November.

3 CHAIR BALLINGER: Yeah, okay.

4 MEMBER MARCH-LEUBA: Let's try to figure
5 out what we want to say in the letter before we write
6 the letter. We always end up having a 120 page
7 compendium of irrelevant stuff.

8 CHAIR BALLINGER: Until we get the input
9 that Dave will assemble, we really won't know. I
10 mean, I have some general ideas, but I don't know.

11 MEMBER MARCH-LEUBA: To write a useful
12 letter, you need to know what You're saying before you
13 start to put in --

14 CHAIR BALLINGER: I suspect that we'll
15 know before the full committee meeting at least in
16 general. But it might change during the full
17 committee discussion.

18 We're rapidly approaching beating a dead
19 horse stage. Any other comments from folks? And I'll
20 talk with Dave during the week, I suppose, at his
21 convenience.

22 Okay. I think I understand what we're
23 doing, and everybody seems to more or less agree. If
24 I wait five minutes, we'll have a different vote. So
25 let's not wait five minutes. So I think we are done

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1 for the day unless there are other comments that we
2 need to address.

3 Hearing none, I knew this was going to be
4 an interesting discussion. Thank you very much. And
5 we will, I guess, see you actually in November in
6 person, right?

7 MEMBER REMPE: We hope so.

8 CHAIR BALLINGER: Yeah, we hope so. We
9 hope so.

10 MEMBER REMPE: Thanks, Ron.

11 CHAIR BALLINGER: Thanks.

12 MEMBER REMPE: Thanks to the staff for
13 their presentations.

14 CHAIR BALLINGER: Yeah, yeah, thanks for
15 the staff. Okay. We're done. We are adjourned.

16 (Whereupon, the above-entitled matter went
17 off the record at 3:47 p.m.)

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

October 18, 2023

[OPEN SLIDES](#)

Opening Remarks

Scott Krepel
Branch Chief
Division of Safety Systems

Overview of Increased Enrichment Rulemaking

Philip Benavides
Project Manager

Reactor Rulemaking & Project Management Branch

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.

SRM-SECY-21-0109 Overview

- [SRM-SECY-21-0109 issued on 3/16/22](#), in response to SECY-21-0109.
 - The Commission has approved the staff's proposal to initiate a rulemaking to amend requirements for the use of light water reactor fuel containing uranium enriched to greater than 5.0 weight percent uranium-235.
 - Provisions to the rule should only apply to High-Assay Low Enriched Uranium (HALEU).
 - Fuel Fragmentation, Relocation, and Dispersal (FFRD) should be appropriately addressed.
 - Staff should take a risk-informed approach.

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
- **Stakeholder Involvement:**
 - Public Meeting scheduled for 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:**
 - Control Room Requirements (10 CFR 50.67 and GDC-19)
 - 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)
 - Fuel Fragmentation, Relocation, and Dispersal

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.

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: 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

Questions

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

- Final Rule issued in 1998
- Rule permits exemptions to 10 CFR 70.24 requirements
- Current rule limits application to enrichments of $\leq 5\%$ weight Uranium-235
- Applicable at operating Part 50 and 52 licensees
- Utilizes k-effective acceptance criteria with required probability and confidence levels

10 CFR 50.68: Alternatives

1. *No Action* - New and Spent Fuel Criticality Safety is determined in accordance with 10 CFR 70.24 or an approved plant-specific exemption
2. *Rulemaking* - Increase Enrichment limit in 10 CFR 50.68(b)(7) to < 20.0% wt U-235
3. *Rulemaking* - Remove Specific Enrichment Limit and replace with Tech Spec Design Feature Limits (**recommended**)

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

Questions

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: 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 with Table S-3 data as bounding
2. *Rulemaking* - Pursue the necessary environmental analysis to justify continued use of Table S-3 for increased enrichment and then pursue rulemaking to modify Table S-3 (**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

10 CFR 51.52: Alternatives

1. *No Action* - Maintain current regulatory framework by assessing environmental impacts from transportation of fresh fuel enriched above 5% U-235 per 10 CFR 51.52(b) on a case-by-case site-specific basis.
2. *Rulemaking* - Pursue the necessary environmental analysis to justify continued use of Table S-4 for increased enrichment and then pursue rulemaking to modify Table S-4 (**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

Questions

Packaging Requirements of 10 CFR 71.55

Jason Piotter

Containment, Thermal, Chemical & Fire Protection Branch

NMSS

Packaging Requirements of 10 CFR 71.55: Summary of Regulatory Issue

Current Regulations

- § 71.55(b) applicants evaluate a single package, optimally moderated and reflected
 - § 71.55(g) Provides an exception for package containing UF₆
 - § 71.55(g)(4) Specifies that enrichment cannot exceed 5 weight percent U-235

Regulatory History

- Proposed rule (§ 71.55(g)) issued 67 FR 21390, April 30, 2002, Final Rule issued 69 FR 3698, January 26, 2004
- Codified NRC longstanding practice to provide an exception to § 71.55(b)

External Issues related to enrichment limit of 5 weight percent

- ANSI N14.1, ISO 7195, and DOT limit enrichment in cylinders larger than 8 inches in diameter to 5 weight percent U-235
- IAEA Standards in SSR-6 limit exception to 5 weight percent U-235 for international transportation.

10 CFR 71.55: Certificate of Compliance (CoC) Options

Options for seeking approval by CoC

- Evaluate UF₆ packages with optimum moderation
 - current package design
 - redesigned package
- Request an exemption to § 71.55(b)
- Request approval under § 71.55(c) for an exception to the optimum moderation requirement in § 71.55(b). (Requires special design feature and adm. controls.)

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 UF₆ 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 UF₆ transportation package designs?

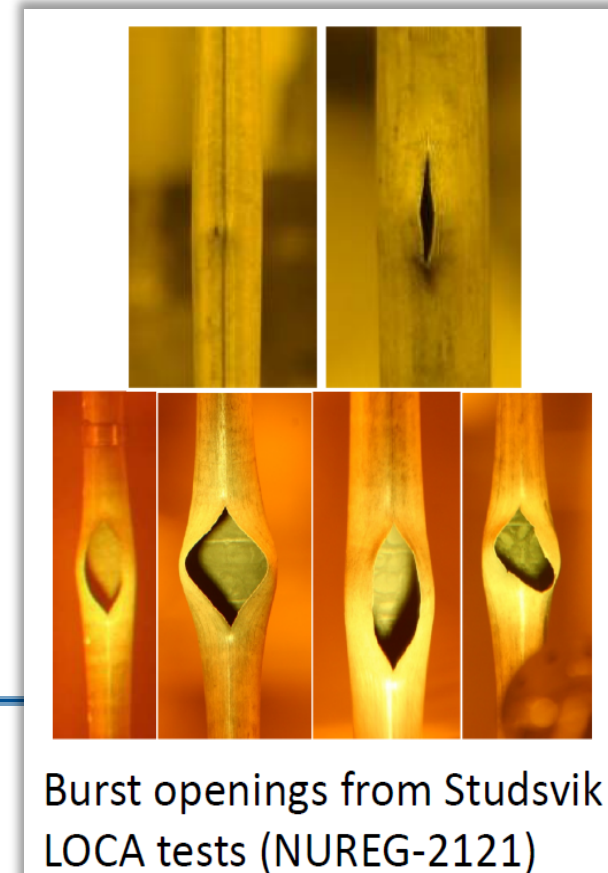
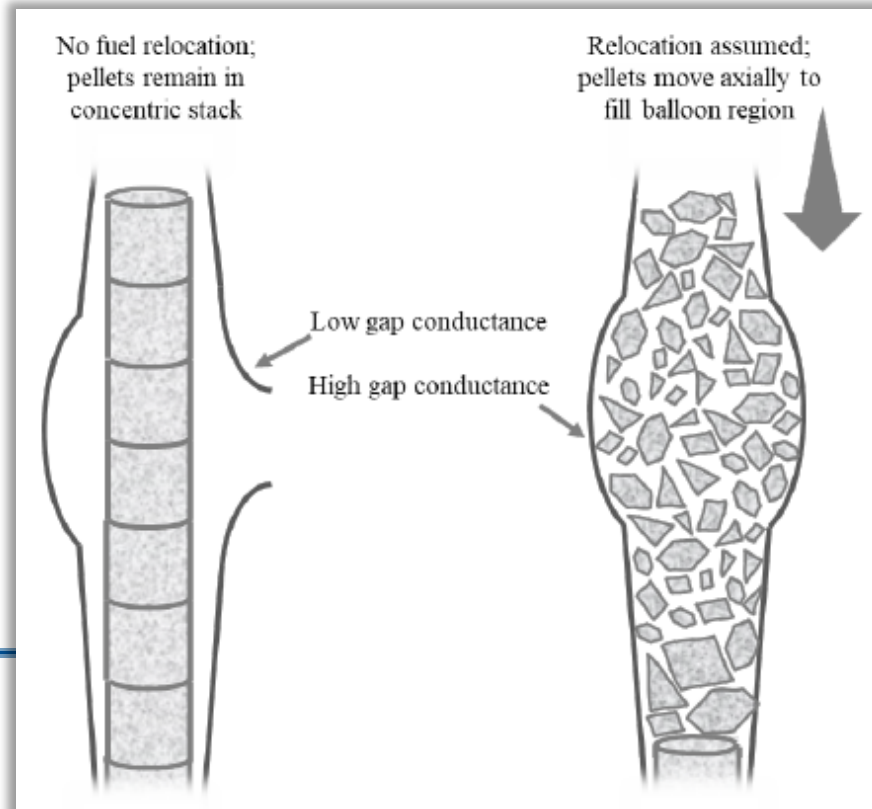
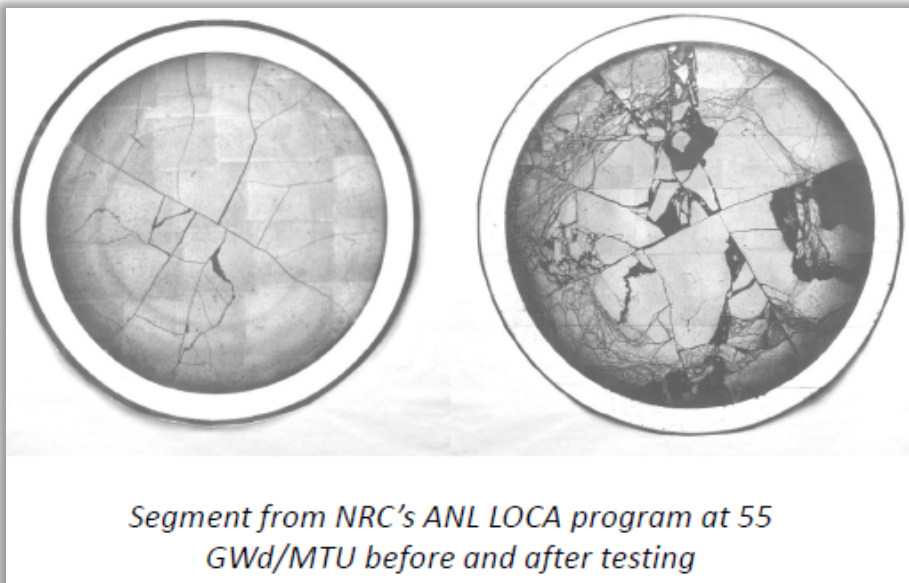
Questions

Fuel Dispersal

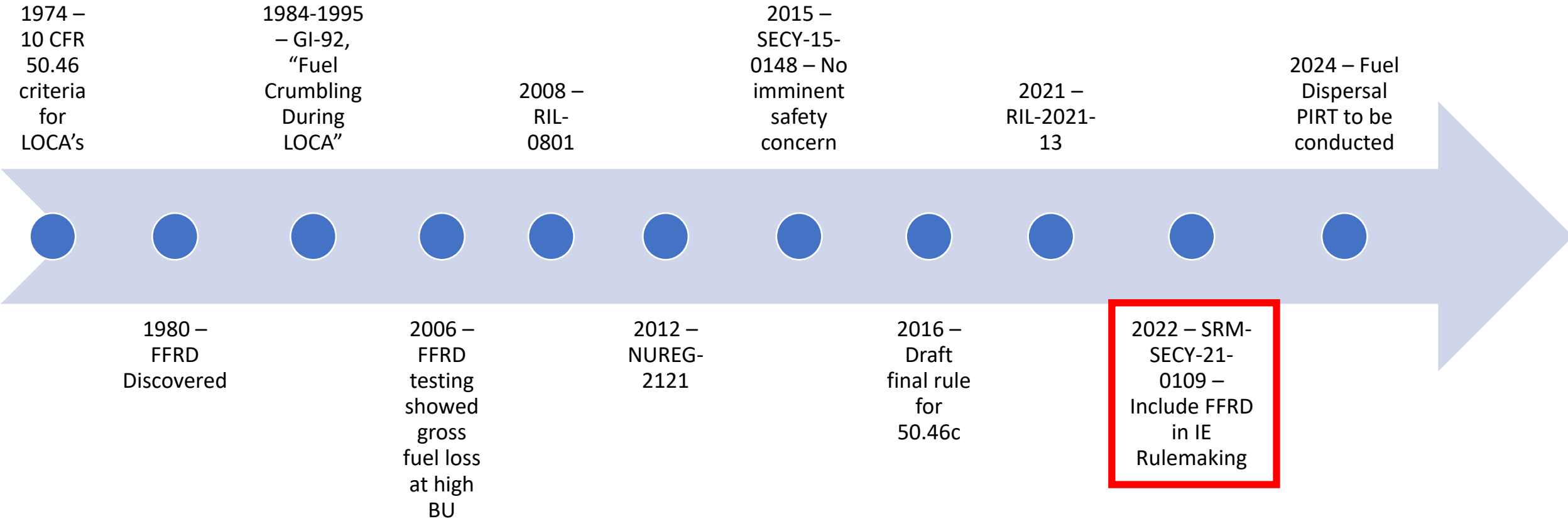
Joseph Messina
Ashley Smith
Nuclear Methods and Fuel Analysis
NRR

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



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

- **50.46a-style modification of ECCS requirements**
- 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 *may* 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

- **Safety demonstration for post-FFRD consequences**
 - 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

- **Probabilistic fracture mechanics to show that leaks in large pipes will be identified before failure, precluding the need to analyze LBLOCAs**
 - 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.

Questions

Backup Slides

FFRD: Dispersal Estimates

- 2014 NRC RES nominal calculations predicted up to 207 kg of fuel dispersed at current BUs

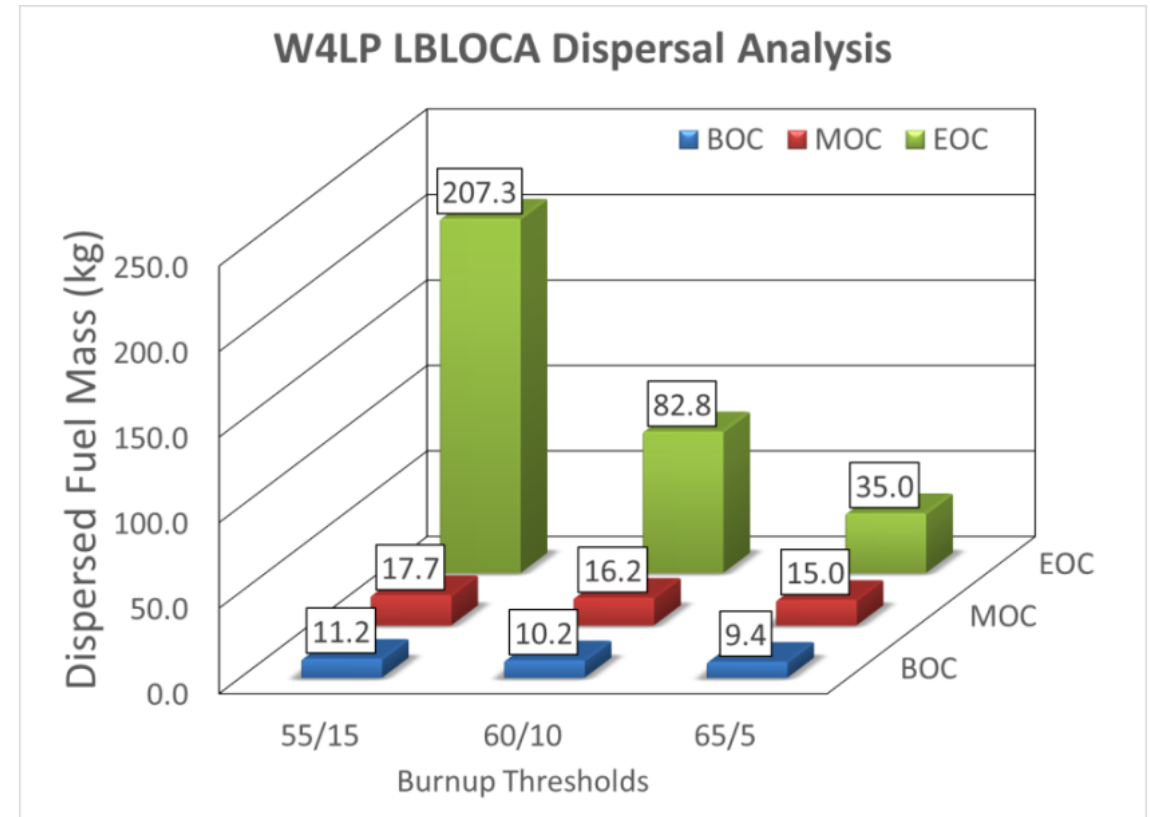
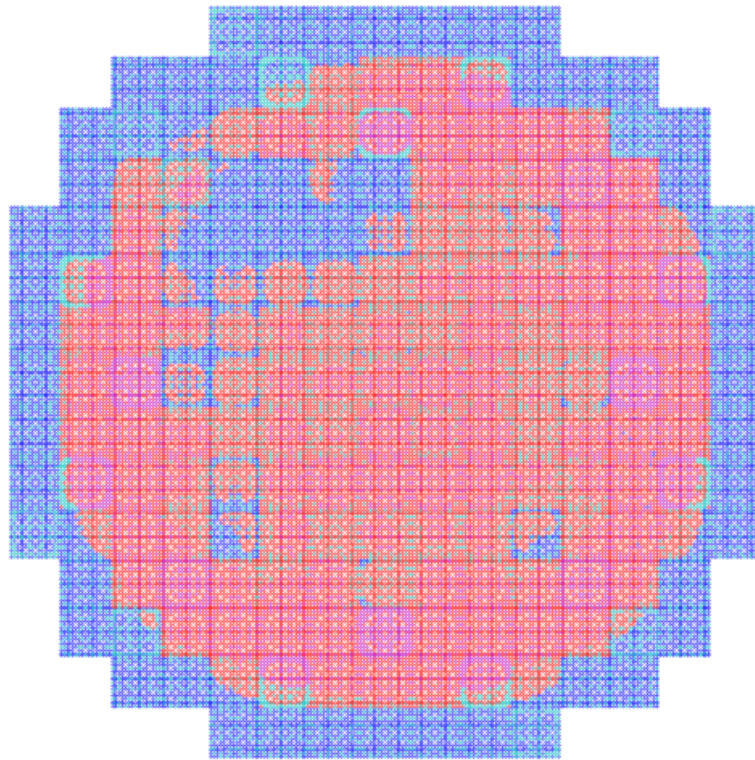


Figure 7.3-11 from "Report on Fuel Fragmentation, Relocation, and Dispersal," NEA/CSNI/R(2016)16, OECD Nuclear Energy Agency, October 2016.

FFRD: Dispersal Estimates

- 2023 RES calculations estimated 0.6% to 3.5% of the fuel in the core is dispersed at HBUs



Core map showing burst and non-burst rods for the base case. Red and magenta indicate burst IFBA and non-IFBA rods, respectively; blue and cyan indicate non-burst IFBA and non-IFBA rods, respectively

| Parameter | Base Case | Chopped Cosine Power Shape | Top Peak Power Shape | Top Peak Power Shape (1 ECCS train) |
|------------------------------|-----------|----------------------------|----------------------|-------------------------------------|
| Burst rods (%) | | | | |
| IFBA | 64 | 68 | 76 | 78 |
| Non-IFBA | 40 | 32 | 69 | 80 |
| Total | 58 | 58 | 74 | 78 |
| Fuel dispersal (%) | | | | |
| All fragment sizes | 2.3 | 2.8 | 3.5 | 3.4 |
| Fragments < 1 mm | 1.1 | 1.9 | 2.1 | 2.1 |
| Fragments < 1 mm above burst | 0.6 | 1.3 | 1.1 | 1.1 |

Table II – Dispersal Estimates from “NRC’s Methodology to Estimate Fuel Dispersal during a Large Break Loss of Coolant Accident,” A. Bielen, J. Corson, and J. Staudemeier, NURETH, August 2023 (ML23116A214).

Fuel Dispersal: FRN Questions

1. Are there any other alternatives not described in Appendix F of the regulatory basis on FFRD that the NRC should consider? Are there elements of the alternatives presented or other alternatives that the NRC should consider? Please provide a basis for your response.
2. Stakeholders previously expressed concerns on the proposed § 50.46a rule when it was initially proposed in 2010. What concerns about § 50.46a (i.e., Alternative 2) exist in today's landscape? Please provide a basis for your response.

Fuel Dispersal: FRN Questions

3. Under Alternative 2, as currently proposed in the regulatory basis, the staff would apply the regulatory precedent under which fuel dispersal that would challenge current regulatory requirements would not be permitted under loss-of-coolant accident (LOCA) conditions. Would the increased flexibilities gained from best-estimate assumptions and methods employed during large-break LOCA analyses make this alternative reasonable? Please provide a basis for your response.
4. What changes to plant operations, fuel designs, or safety analysis tools and methods would be necessary under each proposed alternative? Please provide a basis for your response.

Fuel Dispersal: FRN Questions

5. Provide any information that would be relevant to more accurately estimate costs associated with each proposed alternative. Please provide a basis for your response.
6. What are the pros and cons of each alternative, including the degree to which each alternative is consistent with the principles of good regulation?