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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
+ + + + +
734TH MEETING
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

WEDNESDAY

APRIL 8, 2026

+ + + + +

The Advisory Committee met at Two White
Flint North, 11545 Rockville Pike, Rockville,
Maryland, and via videoconference, at 8:31 a.m. EDT,
Gregory H. Halnon, Chair, presiding.

COMMITTEE MEMBERS:

- GREGORY H. HALNON, Chair
- DAVID A. PETTI, Vice Chair
- CRAIG D. HARRINGTON, Member-at-Large
- ANNIE M. KAMMERER
- WALTER L. KIRCHNER
- ROBERT P. MARTIN
- SCOTT P. PALMTAG
- THOMAS E. ROBERTS
- MATTHEW W. SUNSERI

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ACRS CONSULTANT:

RONALD BALLINGER

DESIGNATED FEDERAL OFFICIAL:

KENT HOWARD

ALSO PRESENT:

MARKUS BURKARDT

EDWIN LYMIN

TAMARA SKOV

SANDRA WALKER

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

(8:31 a.m.)

CHAIR HALNON: The committee will now come to order.

This is the first day of the 734th meeting of the Advisory Committee on Reactor Safeguards. I am Greg Halnon, Chairman of the Committee.

ACRS members in attendance in person are Craig Harrington, Annie Kammerer, Walt Kirchner, Bob Martin, Scott Palmtag, Dave Petti, Tom Roberts, and Matt Sunseri. Our consultant Ron Ballinger is also in attendance.

If I have missed anyone, please speak up at this point.

(No response.)

CHAIR HALNON: Kent Howard of the ACRS staff is the Designated Federal Officer for today's full committee meeting. We have a quorum for today's meeting.

The ACRS was established by the atomic Energy Act and is governed by the Federal Advisory Committee Act. Under the Atomic Energy Act, ACRS must advise the Nuclear Regulatory Commission on the hazards of proposed and existing reactor facilities and the adequacy of proposed safety standards.

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1 Following Executive Order 14300, the Committee focuses
2 those activities necessary to fulfill its statutory
3 obligations.

4 As a result, ACRS is prioritizing the
5 review and reporting of new reactor facilities and new
6 or revised proposed safety standards, with particular
7 attention to issues that are unique, novel, and
8 noteworthy. The Committee will consider other nuclear
9 safety matters at the direction of the Commission.

10 Please note, the ACRS speaks only through
11 its published letter reports. All member comments
12 should be regarded as only the individual opinion of
13 that member, not a Committee position.

14 Information about ACRS activities, such as
15 letters, meeting rules, and transcripts are on the NRC
16 public website and can be found by searching for
17 "About Us ACRS" on NRC's home page.

18 The ACRS provides an opportunity for
19 public input and comment on relevant technical issues
20 during our proceedings. For this Full Committee
21 Meeting we have received no written statements or
22 requests for verbal comment. Written statements may
23 still be forwarded to the Designated Federal Officer.
24 We'll also refer to that as the DFO.

25 We have set aside time in this meeting for

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1 public verbal comments on Committee technical matters.

2 A transcript of today's meeting is being
3 kept and will be posted on our website. When
4 addressing the Committee, the participants should
5 first identify themselves and speak with sufficient
6 clarity and volume so that they may be readily heard.
7 If you are not speaking, please mute your computer on
8 Teams. If you are participating by phone, press Star-
9 6 to mute your phone and Star-5 to raise your hand on
10 Teams.

11 The Teams chat feature is only for
12 communicating IT issues or brief meeting logistics.
13 Please do not use it for comments or questions on the
14 topics under Committee discussion. For everyone in
15 the room, please put all your electronic devices in
16 silent mode, and mute your laptop microphone and
17 speakers. In addition, please keep sidebar
18 discussions in the room at a minimum, since the
19 ceiling microphones are "live" during the meeting.

20 For the presenters, your table microphones
21 are unidirectional, and you'll need to speak into the
22 front of the microphone to be heard online.

23 Finally, if you have any feedback for the
24 ACRS about today's meeting, please fill it out or fill
25 out the public meeting feedback form on the NRC

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1 website.

2 And just a note about the agenda published
3 in the Federal Register on March 11th: the topic
4 advertised for the Committee to undertake this
5 afternoon -- Draft Rule on Licensing Requirements for
6 Microreactors and Low-Consequence Reactors, Part 57 --
7 will not take place this month because the draft rule
8 has not yet been published. In its place, the
9 Committee will proceed with other business, including
10 letter writing.

11 So, just briefly, this morning we will run
12 through the EPRI Topical Report on the Loss-of-
13 Coolant-Accident-Induced Fuel Fragmentation,
14 Relocation and Dispersal with Leak-Before-Break
15 Credit, also known as Alternative Licensing Strategy.

16 In place of this afternoon where the draft
17 rule of Part 57 was going to be looked at, we will
18 continue with the letter writing, the ALS.

19 So, Bob, today is your day.

20 MEMBER MARTIN: Yeah.

21 CHAIR HALNON: Tomorrow, we will start the
22 day with the planning procedure session. We'll have
23 an open session and probably a short closed session.

24 After the closed session is complete we'll
25 continue with letter writing and committee business.

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1 At this point, I think you should just, for Friday you
2 should just gauge the progress yourself. It's very
3 possible we won't need Friday morning, but we will
4 keep that on the agenda just in case we have some
5 additional business to do.

6 At this point I want to just say is there
7 any comments, opening comments from any of the
8 members?

9 (No response.)

10 CHAIR HALNON: Okay. Given that, I'd like
11 to ask Bob Martin, the Subcommittee Chair, to lead us
12 in our first topic for today's meeting, the EPRI
13 Topical Report that I mentioned earlier.

14 And, I turn the meeting over to Bob.

15 MEMBER MARTIN: Okay. Thanks, Chair.

16 So, as Chair Halnon has noted, we are
17 going to spend most of the morning and, hopefully, not
18 much beyond that, but it's letter writing, so we'll
19 see, addressing the topic of EPRI's Alternative
20 Licensing Strategy related to loss-of-coolant-
21 accident-induced fuel fragmentation, relocation and
22 dispersal with leak-before-break credit.

23 On March 17th a subcommittee meeting was
24 held with representatives of EPRI, EPRI's Topical
25 Report Team, and the staff's Safety Evaluation Group,

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1 regarding the alternative license strategy the ALS.

2 The technical approach design for
3 pressurized water reactors, PWRs, that allows the
4 exclusion of fuel fragmentation, relocation, and
5 dispersal, FFRD, from the loss-of-coolant accident
6 analysis.

7 The methodology supports the possibility
8 of achieving higher fuel burnup. ALS methodology is
9 documented across three separate reports, those being
10 a loss-of-coolant-accident-induced fuel fragmentation,
11 relocation, and dispersal with leak-before-break
12 credit, ALS. That is what we were formally reviewing
13 and the letter really is focused on.

14 We have looked, considered the other two
15 documents, the first being materials reliability
16 program xLRP; estimation of PWR loss-of-coolant
17 accident frequency, MRP-480; and the LOCA analysis of
18 fuel fragmentation, relocation, and dispersal for
19 Westinghouse 2, 3, and 4-loop plants as kind of
20 documents that were feeding and providing additional
21 insight into the main document, main ALS document
22 provided by EPRI.

23 The Final Safety Evaluation Reports are
24 anticipated to be issued in the next month or two this
25 year. During the subcommittee meeting on March 17th,

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1 it was determined that a staff or applicant
2 presentation was not necessary for this morning's full
3 committee session.

4 I would now like to have a discussion if
5 we should write a letter report or would a meeting
6 summary suffice?

7 So, we can do that. I have, obviously,
8 written a draft letter. I think there's -- we did
9 talk about it briefly, of course, at the end of the
10 subcommittee meeting.

11 Is there any change of heart? You've had
12 the letter. I did get a number of comments from Tom
13 and Dave. They're good comments, good, a lot of
14 suggestions to soften some of the language and general
15 improvement of the clarification of the topic.

16 I didn't get any feedback negative in the
17 sense that it would be better off as a summary. But
18 this is one of those things, speak now or forever hold
19 your peace.

20 We're still on track to go along with
21 letter writing today. Otherwise, we have nothing to
22 do the rest of the day.

23 (Simultaneous speaking.)

24 (Laughter.)

25 CHAIR HALNON: Okay. Can you summarize at

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1 least what your conclusions and recommendations are,
2 and then we can make an assessment whether or not this
3 raises to the letter of needing -- I mean to the point
4 of needing the letter?

5 MEMBER MARTIN: Right. Right.

6 So, obviously, it reflects a lot of work
7 done by, like, EPRI and the industry.

8 There's several conclusions. And at the
9 high level, the comment which, both speaking for
10 myself but today I am speaking on behalf of the
11 Committee since this is a draft consensus letter, is
12 that we're generally positive about the content of the
13 approach.

14 It is rather precedent-setting in the
15 sense that this is a use of the leak-before-break
16 approach which goes back 37 years, 38 years into the
17 late Eighties, which has only been used for, like, the
18 pipe whip-type analysis. And even back then there was
19 comment by the Commission that, you know, in fact I
20 would say encouraged industry to look at applying it
21 to, you know, to LOCA analysis.

22 And it's taken Cody some odd years to get
23 to that point.

24 So, I think this reflects a long history
25 on this topic. It fits into, you know, other topics

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1 that we have ongoing now related to increased
2 enrichment, and rulemaking associated with 50.46.
3 It's part of a larger puzzle, I think, a lot of moving
4 parts right now.

5 So, I'm -- of course there are other
6 conclusions. I'm encouraged to move forward with a
7 letter. It's meaningful, I think, particularly at
8 this time for the rulemaking going on at the moment.

9 MEMBER ROBERTS: Yeah, this is Tom.

10 I'll summarize the recommendation and
11 conclusion. I think we're largely in agreement with
12 the staff, which might push towards a meeting summary.

13 But there is some meaningful discussion on
14 the sensitivity study that the staff did in support of
15 their evaluation which, which used some conservative
16 assumptions to model a dispersal configuration which
17 and showed the ability to cool it.

18 And there is some concern that at least I
19 heard in the subcommittee meeting in the letter on how
20 much that study could be extrapolated to other
21 conditions. And so, the letter, the recommendation in
22 the draft letter recommends caution to the staff on
23 that.

24 And I think that probably in itself, in
25 addition to what Bob said about the somewhat

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1 innovative use of a 30, 40-year-old concept I think
2 probably warrants a letter.

3 CHAIR HALNON: Other comments before I --
4 is this a, you said it's precedent setting, it is a
5 first step to a larger concept or a larger way
6 approach to licensing across the board?

7 Or are we limiting it just to saying that,
8 okay, we've got this, it's for PWRs. There's not that
9 many welds out there that it even applies to anymore
10 because they've all been mitigated. Are we just in a
11 situation where it's going to sit on the shelf and not
12 get used all that much?

13 MEMBER MARTIN: Oh, it's absolutely going
14 to be used. I mean, I guess I haven't said it out
15 loud, but this is all related to phenomena associated
16 with higher burnups.

17 And, you know, I can tell you from my past
18 life 20 years ago this was percolating up at the time.
19 And as somebody that was working in methods, it was
20 very annoying that there, the science wasn't there to
21 back up the word arguments that we had at those times.

22 So, finally, we have, I think, a better
23 argument. And it fits well within or with the
24 discussion and the technical basis for the rulemaking.
25 We, of course, we identify it as the increased

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1 enrichment rulemaking but it really is the higher
2 burnup and increased enrichment rulemaking.

3 So, it's part of the, it's part of that
4 story. I think it's a key part because when we first
5 were introduced to what EPRI was doing a few years
6 ago, they presented five different options,
7 alternatives.

8 VICE CHAIR PETTI: Staff did.

9 MEMBER MARTIN: The staff. The staff did.

10 Well, the 2020 report, you can correct me,
11 that identified five --

12 PARTICIPANT: Things they looked at.

13 MEMBER MARTIN: Yeah. They, like, so it
14 was EPRI's 2020, I don't know, if it was called the
15 Topical Report at the time, Technical Report, which
16 went through the five items, yes. The staff did, did
17 present it but EPRI did talk about it.

18 So, then it settled in on what we are
19 talking about today, or three weeks ago. And I think
20 even when we had the meeting -- I guess 2023, '24, or
21 is it '24? Can't quite remember what it was. But at
22 the time I think our impression was that it was going
23 to go a different way, different direction.

24 And so, this is a little, you know, maybe
25 a little bit of a surprise pivot, maybe not. But

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1 there was a feeling at that time that if you went a
2 different route there would be a considerable amount
3 of work maybe still be required that may even derail
4 the rulemaking with regard to increased enrichment.

5 I think this really, as I said before adds
6 that necessary puzzle piece that there's a piece of
7 evidence, there's really not all the evidence, but a
8 piece of evidence supporting the, you know, rulemaking
9 down the road. But, obviously, it supports the
10 pathway today without any rulemaking, you know, in
11 case the rulemaking gets derailed for some reason.

12 So, it's, it's precedent setting. And
13 there's a section that talks about the precedent.

14 CHAIR HALNON: I guess the question, and
15 it's not the answer to the FFRD story, though. The
16 puzzle, there's still some pieces that need to be, you
17 know, clearly if you take the burst out there's no
18 FFRD issue. But --

19 MEMBER MARTIN: Right. Right.

20 Well, but it did go beyond; right? I
21 mean, Tom brought it up, there was analysis done where
22 dispersal was assumed.

23 And, you know, a key part of their
24 argument, while not perfect, but it provided, you
25 know, another, another perspective, another, like,

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1 quantitative form of evidence that the dispersal
2 question as it relates to core cooling, core
3 coolability, was a lesser concern than maybe it was
4 otherwise thought of before.

5 VICE CHAIR PETTI: See, my -- this is Dave
6 -- my view is that this is kind of the other bookend.
7 I mean, we wrote a letter, on increased enrichment and
8 transition break size, which had a fair amount of
9 support by some stakeholders.

10 This is the other one, and to not write
11 the letter, just to speak on it. We've spent many,
12 many meetings culminating in that one letter recently,
13 this one. And probably the last one. So, I think it,
14 it --

15 (Audio interference.)

16 CHAIR HALNON: Does it close it though
17 completely or are we still building this story?

18 VICE CHAIR PETTI: Well, no. I mean, I
19 think, I think it all depends on what you think it --
20 no burst from one perspective closes it. Do we know
21 everything about FFRD? No. Will we ever know
22 everything about FFRD? Probably not. Is there still
23 research going on in that area? Yes.

24 But, you know, they found a way to be able
25 to keep moving the ball down the field without having

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1 all the science.

2 CHAIR HALNON: And, Bob, I have not
3 studied the letter and not comfortable saying that
4 it's in there or not. But are we continuing to build
5 that story?

6 MEMBER MARTIN: Absolutely.

7 CHAIR HALNON: I mean, does the letter
8 identify transition break size as being part of the
9 story and this -- because what I envision 10 years
10 from now is we're going to have ten letters, all very
11 siloed and focused, and you have to put them all
12 together and figure out the whole story.

13 Are we building that story in our letters
14 so that we can point backwards and say, look, --

15 MEMBER MARTIN: Oh, absolutely.

16 CHAIR HALNON: -- we have Step 1, 2, and
17 3?

18 MEMBER MARTIN: I think the leak-before-
19 break credit is really a unique part of the overall
20 story, you know. So, it's, this is not a small
21 incremental step in the ultimate path towards the
22 rulemaking which we expect. It is really a key piece.

23 So, obviously, I'm also thinking, I spent,
24 you know, the last few weeks working on this letter.

25 CHAIR HALNON: You studied it.

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1 MEMBER MARTIN: I'm, I'm ready to present
2 it and get it out there.

3 But, obviously, it's appropriate for the
4 Committee to do the due diligence right now and have
5 this discussion.

6 VICE CHAIR PETTI: So, you know, I think
7 the letter captures most of the thought points. I
8 think our discussion's gonna focus on maybe some
9 context or things like that. Well, we didn't talk
10 about this. We need to talk about -- I don't think
11 that that's indicative, it really isn't.

12 MEMBER MARTIN: No, I appreciate that,
13 Dave.

14 That's always what you worry about when
15 you write these things. What did I miss on this?

16 MEMBER SUNSERI: So, I mean, just one
17 person's thought on this thing, but, you know, when we
18 review a draft letter that puts us in more or less a
19 deliberative process. So, I think we would answer a
20 lot of these questions that we are anticipating but we
21 haven't reviewed and deliberated the letter.

22 My recommendation would be we deliberate
23 the letter and when we get done we decide do we
24 publish it or do we scrap it, for lack of better
25 words?

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1 CHAIR HALNON: Okay. So, from what I've
2 seen, I get the general positive aura from the
3 Committee that the letter is probably -- right, I
4 think Matt's got a really good point, let's go ahead
5 and get through the letter as you have it written,
6 because that may take an hour-and-a-half to read it
7 in.

8 But that's sarcastic. I'm sorry. It is
9 a long letter. Yeah, I've not, I haven't seen a
10 letter 400 lines long that agreed with the topic, you
11 know.

12 VICE CHAIR PETTI: Eleven point font.

13 MEMBER MARTIN: Well, I originally did it
14 at 14 point font. And I go, ooh, that's gonna scare
15 people.

16 CHAIR HALNON: At this point, just before,
17 I'm going to check with my DFO, we're going to read
18 the letter in. After that is there any need for our
19 court reporter?

20 MEMBER ROBERTS: After we read it in, yes,
21 you can let the court reporter go.

22 CHAIR HALNON: All right. So, let's read
23 the letter in, take public comments. Then we'll take
24 a break, come back.

25 MEMBER MARTIN: And I just want to read

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1 into the rec -- for the record, did receive feedback,
2 as I mentioned, from Tom and Dave. Obviously from
3 Ron. Ron, our consultant was really a key contributor
4 to this review.

5 The draft letter has been through a prop
6 check, so there is no proprietary information.

7 And I did make some changes from what they
8 received. But these were all mostly, you know,
9 there's a lot of editorial-type things. Anything by
10 content deleted rather than added.

11 CHAIR HALNON: Okay, you had a good point.

12 Before we get into letter reading I was
13 going to ask Ron, Ron, did you have any comments from
14 a consultant perspective on the whole topic? You've
15 been following this for?

16 DR. BALLINGER: Yeah. I can't add too
17 much more. But this is an application of about the
18 last 30 years of research in this area to the issue of
19 leak-before-break, and LOCA, and stuff like that.

20 There's some subtleties, I think, in the
21 SE where there's a reference in the SE to a document
22 which is not referenced in MRP-480, which is what
23 you're reviewing, which dealt with the issue of
24 inspections of similar metal welds and others, and the
25 requirements related to that which I think it was in

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1 the letter but I think it's not now.

2 So, I think that's pretty important
3 because that's the, that's the part that will cost the
4 industry a lot of money if they have to do additional
5 inspections. So, this NEI document dealt, it deals
6 extensively with the rationalization for why they
7 don't need to do that.

8 And, in effect, in the SE the staff has
9 bought off on that. So, I don't think that should be,
10 not cautioned, not mentioned.

11 But other than that, you know, I think Bob
12 has done a pretty darn good job at writing the letter
13 which will no doubt be --

14 CHAIR HALNON: Okay. Thanks, Ron. Okay,
15 Bob, why don't you go ahead.

16 DR. BALLINGER: But there's also
17 information later on I think the Committee is going to
18 be dealing with BWRs which don't allow leak before
19 break. But they still have the same inspections,
20 mitigation, leak detection issues and stuff like that
21 that they're dealing with here.

22 So, I think the Committee's going to see
23 this in some form or another on the BWR side.

24 CHAIR HALNON: Okay, thanks, Ron.

25 MEMBER MARTIN: Just a moment ago I sent

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1 you all a tracked changes version. I did send out a
2 version, too, at least for a couple of you all that
3 had provided comments. And that was a fail. It had
4 accidentally accepted all the draft changes and sent
5 you two copies of the same thing.

6 This time I, I did a quick compare. And
7 I checked it before I sent it. So, you will see the
8 tracked changes. To Ron's point, you'll see the one
9 deletion related to the similar metal welds which
10 appear as a conclusion. I think conclusion two or
11 three in that space.

12 But anyway, we'll read it in and then,
13 obviously, we'll go through the normal deliberation
14 process.

15 Dear Chairman Nieh, during the 734th
16 Meeting of the Advisory Committee on Reactor
17 Safeguards, held April 8th through 10th, 2026, we
18 completed our review of EPRI Topical Report 300 -- ah,
19 better -- 3002028673, titled Loss-of-Coolant-Accident-
20 Induced Fuel Fragmentation, Relocation and Dispersal
21 with Leak-Before-Break Credit, Alternative Licensing
22 Strategy, Revision 0, and the associated NRC staff
23 safety evaluation, SE.

24 This review was supported by the ACRS
25 Reactor Safety Standards Subcommittee which met on

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1 March 17th, 2026.

2 During the meetings we had the benefit of
3 discussions with the NRC staff and EPRI
4 representatives, as well as the benefit of the
5 reference documents.

6 Conclusions and recommendations.

7 The Committee offers the following
8 conclusions and recommendations:

9 ACRS finds that the EPRI alternative
10 licensing strategy, ALS, is grounded in established
11 regulatory precedent and provides a technically sound
12 approach in safety issues posed by loss-of-coolant
13 accident, LOCA, induced fuel fragmentation,
14 relocation, dispersal, FFRD, in high burnup
15 pressurized water reactor, PWR, fuel.

16 The NRC staff SE, with the applicable
17 limitations and conditions, L&Cs, stated therein
18 provides an appropriate basis of plant-specific
19 license-amendment requests referencing this
20 methodology.

21 Two. The LBB-based exclusion of fuel
22 dispersal from the 10 CFR 50.46 design basis for
23 large-break LOCAs is the ALS's most consequential
24 element. The xLPR probabilistic fraction mechanics
25 analysis, documented in the MRP-480 Report,

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1 establishes that RCS -- we've not defined RCS before,
2 so keep that in mind --

3 What's that?

4 CHAIR HALNON: We'll work on that.

5 MEMBER MARTIN: Okay, yeah.

6 -- reactor coolant system main loop
7 rupture frequency remains well below 10 to the minus
8 6 reactor year over an 80-year plant life, consistent
9 with NUREG-1829.

10 The analysis further shows that detectable
11 leakage would precede any large-break condition by at
12 least 19 months, more than sufficient time for
13 operators to identify and respond to leakage before
14 the loss-of-coolant condition escalates. We agree
15 with the staff that this provides an adequate basis to
16 exclude consideration of fuel dispersal and large-
17 break LOCA analyses.

18 Number three. For small and intermediate
19 break LOCAs fuel dispersal is excluded through a no
20 burst demonstration, applications of Westinghouse's
21 FULL SPECTRUM LOCA methodology show that peak cladding
22 temperature remains below the cladding burst threshold
23 with positive margin for the analyzed plant
24 configurations.

25 Because cladding burst is a necessary pre-

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1 condition for fuel dispersal. The absence of fuel --
2 oh, excuse me -- absence of burst eliminates the
3 dispersal pathway. We agree with the staff that this
4 provides an adequate basis to exclude consideration of
5 fuel dispersal in small and intermediate break LOCA
6 analyses.

7 Four. Non-piping RCS components fall
8 outside the scope of 10 CFR 50.46(c), which limits
9 ECCS analysis to piping breaks.

10 The ALS documents that the integrity of
11 these components is addressed through conservative
12 design rules, operating restrictions, in-service
13 inspection, and as necessary, component-specific
14 surveillance. We agree with the staff that these
15 existing regulatory commitments constitute an adequate
16 defense-in-depth basis for addressing non-piping RCS
17 components within the context of the ALS.

18 Five. The NRC staff performed an
19 independent thermal hydraulic analysis using the NRC
20 TRACE code to bound the consequences of fuel dispersal
21 with the ECCS analysis. This analysis was intended to
22 demonstrate defense-in-depth beyond the LBB-based
23 technical justification that supports assuming no fuel
24 dispersal.

25 We observe that TRACE does not have the

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1 capability to mechanistically model fuel relocation
2 and dispersal phenomena. And, therefore, the staff's
3 analysis necessarily rests on assumed bounding
4 fragmentation bed configurations rather than
5 predictive simulation. While this sensitivity study
6 provides a useful bounding perspective in support of
7 the ALS, it relies on assumed fragmentation
8 configurations rather than mechanistic modeling of
9 fuel relocation and dispersal.

10 Accordingly, it should not be used a
11 substitute for mechanistic consequence analysis in
12 applications where fuel dispersal behavior is the
13 prime determinant of safety margin.

14 Six. The staff's SE should be issued.

15 Counting on Sandra to scroll up here. Oh,
16 or Tammy. I'm counting on Tammy now.

17 Background.

18 In 1998, the NRC established a program
19 plan for high-burnup fuel that confirmed the current
20 licensing limit of 62 gigawatt days per metric ton of
21 uranium. Peak rod average fuel -- peak rod-average
22 burnup as the ceiling for LWR fuel pending completion
23 of confirmatory research.

24 Above this threshold, and there is a
25 footnote associated with that providing some

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1 clarification. Anyway, we can address that later.

2 Above this threshold the microstructure of
3 high-burnup fuel becomes susceptible to fine
4 fragmentation during a LOCA, potentially leading to
5 fuel relocation with the cladding and dispersal of
6 fragmented materials through burst cladding openings
7 in the reactor coolant system. The phenomena
8 associated with FFRD introduced uncertainties in ECCS
9 performance analysis and coolable core geometry
10 assessment.

11 The existing 10 CFR 50.46 framework does
12 not directly address these uncertainties in the high-
13 burnup regime.

14 EPRI states that a licensing pathway to
15 address these new fuel behavior phenomena involving
16 empirical model development using irradiation data,
17 dispersal consequences model validation, and new or
18 revised regulatory guidance would require an estimated
19 5 to 10 years of additional development. This
20 schedule was judged incompatible with near-term
21 industry plans to deploy higher burnup fuel.

22 In March of '22 the Commission directed
23 the NRC staff through SRM-SECY-21-0109 -- to address
24 FFRD expeditiously in the context of rulemaking to
25 increase the maximum fuel enrichment limit.

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1 Cite the document there.

2 In the first half of 2020, EPRI evaluated
3 five alternative licensing approaches documented in TR
4 3002018457.

5 In February of 2022, EPRI concluded that
6 an LBB-based approach could be developed more
7 expeditiously and was better anchored in existing NRC-
8 approved precedent than the alternatives.

9 In 2024, the 2024 ALS TR represents the
10 matured LBB-based approach, supported by xLPR,
11 probabilistic fracture mechanics analysis, to
12 establish quantitative piping rupture frequency
13 estimates and leak-to-rupture margin.

14 The principal regulatory precedent for ALS
15 is generic letter, GL 84-04 and the resolution of
16 Unresolved Safety Issue USI A-2 in 1987, in which the
17 NRC accepted LBB qualification to eliminate asymmetric
18 blow-down dynamic loads from the design basis under
19 General Design Criteria GDC-4. ALS represents the
20 first use of LBB, leak before break qualification to
21 exclude in LOCA consequence from the design basis,
22 distinct from the structural dynamic load.

23 Discussion.

24 The ALS TR presents a three-tiered
25 technical structure for addressing LOCA-induced FFRD

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1 across the full spectrum of postulate break sizes, PWR
2 primary assistance. This three-tiered structure
3 involves:

4 1) Leak before break exclusion for large
5 break LOCAs;

6 2) A no-burst demonstration for small and
7 intermediate break LOCAs, and;

8 3) A defense-in-depth assessment of non-
9 piping RCS components.

10 The NRC staff SE reviewed the ALS against
11 these elements and established applicability
12 conditions governing plant-specific implementation.

13 The following subsections address the
14 technical basis:

15 Role of leak rate detection and in-service
16 inspection;

17 Consistency with existing regulatory
18 framework;

19 Completeness of the staff's review and the
20 precedent-setting aspects of the methodology.

21 ALS technical basis.

22 The technical basis for each tier of the
23 ALS is described below:

24 Tier 1, large break LOCA.

25 The Tier 1, leak-before-break technical

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1 basis rests on two elements: the very low frequency
2 reactor coolant system main loop rupture, confirmed by
3 xLRP to be below 10 to the minus six reactor year
4 throughout plant life, and consistent with the NUREG-
5 1829 and the demonstrable -- demonstrative -- thank
6 you.

7 These glasses are actually not as good as
8 they should be.

9 -- long leak-to-rupture interval minimum
10 of 19 months under normal operating conditions that
11 allows operators to detect, evaluate, and bring the
12 plant to a stable shutdown condition before rupture
13 could occur.

14 Once in a stable shutdown condition, the
15 high RCS pressure temperature and decay heat that
16 would drive fuel dispersal are consistent with GL 84-
17 04 precedent. ALS seeks the analogous conclusion for
18 FFRD that LBB-qualified piping need not be attuned to
19 initiate fuel dispersal within the 10 CFR 50.46 ECCS
20 analysis.

21 Tier 2, small and intermediate break
22 LOCAs.

23 For sub-main loop breaks up to the largest
24 branch lines -- for example, pressurizer surge lines
25 and ECCS injection lines -- FFRD exclusion is based on

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1 a no-burst demonstration. Application of
2 Westinghouse's FULL SPECTRUM LOCA methodology -- there
3 citing the documents associated with it -- so that
4 peak cladding temperature remains below the cladding
5 burst threshold with positive margin for Westinghouse
6 2, 3, and 4-loop plants.

7 No-burst means no dispersal pathway. This
8 result must be re-demonstrated in any plant-specific
9 license amendment request where plant configuration or
10 fuel design differs from the analyzed cases.

11 Tier 3, non-piping RCS components.

12 Because 10 CFR 50.46(c) limits the
13 obligation to perform ECCS analysis to piping breaks,
14 non-piping RCS components are outside the scope of the
15 FFRD analysis requirement. The ALS documents a
16 defense-in-depth basis for confidence in the integrity
17 of -- let's see -- confidence in the integrity of
18 these components by reference to existing programs,
19 conservative design rules, operating restrictions, in-
20 service inspection, and, as necessary, component-
21 specific surveillance.

22 The ALS TR provides, as an example, the
23 EPRI NP-5769 bolting closure analysis which
24 demonstrates a factor of safety of 2.6 to 3.3 at 1
25 gallon per minute leak rate.

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1 Key role of leak rate detection and in-
2 service inspection.

3 A critical enabler of the Tier 1 leak-
4 before-break argument is the demonstrated
5 effectiveness of leak rate detection, LRD, and in-
6 service inspection, ISI, programs across the operating
7 PWR fleet.

8 In its February 2025 letter on the
9 rulemaking on increased enrichment of conventional and
10 accident-tolerant fuel designs for light-water
11 reactors, the ACRS emphasized the importance of
12 performance monitoring as a key element for robust
13 degradation management program and encouraged the
14 staff to work with industry to develop an optimized
15 fleet-based approach.

16 The ALS framework relies directly on this
17 established degradation management infrastructure and
18 its sustained implementation across the fleet. The
19 reliance is directly supported by MRP-480, the xLRP
20 analysis, which provides a strong technical basis for
21 the effectiveness of LRD and ISI when LRD and ISI are
22 credited in xLRP a calculated probability of main loop
23 piping rupture becomes vanishingly small for
24 conditions representative of current plant
25 operations.

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1 This reflects decades of materials
2 management, proactive inspection, and sustained
3 industry response to operating experience, including
4 enhanced inspection programs such as NEI 03-08.

5 Two results are particularly noteworthy:
6 the lower-bound coping time between the onset of
7 detectable leakage and the progression to potential
8 large break condition is approximately 19 months, far
9 exceeding technical specification response times.

10 In addition, the probability of rupture is
11 nearly eliminated when LRD and ISI are credited
12 relative to already low baseline frequencies.

13 Together, these results provide strong
14 physical and probabilistic grounding for the ALS Tier
15 1 premise, and support the conclusion that the
16 existing fleet management framework already provides
17 the level of assurance on which the ALS relies.

18 In this context the Committee emphasizes
19 that ALS is not based solely on aggregate leakage
20 incident statistics, which are sparse. Consistent
21 with the leak-before-break basis, ALS relies on
22 demonstrated effectiveness of leak detection,
23 inspection, and operator response programs.

24 The Committee also recognizes that
25 operator experience has demonstrated that degradation

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1 mechanisms and reactor coolant system materials can
2 evolve over time and are not always fully anticipated
3 by analytical means. Accordingly, the effectiveness
4 of the ALS framework depends on the continued
5 performance of leak detection, inspection, and
6 degradation management programs to ensure that the
7 assumptions underlying leak-before-break applicability
8 remain valid as plant conditions and materials
9 behavior evolve.

10 Consistency with existing regulatory
11 framework.

12 The ALS's use of leak-before-break
13 qualification to limit design-basis scope is
14 consistent in structure with the treatment of
15 asymmetric blowdown loads under GDC 4 as affirmed by
16 GL 84-04 and the 1987 resolution of USI A-2.

17 This application follows the regulatory
18 logic under which the dynamic effects associated with
19 postulated pipe ruptures in the reactor coolant loop
20 piping need not be considered as design-basis events
21 where plants meeting the specified criteria that leak-
22 before-break behavior can be demonstrated.

23 The extension of leak-before-break from
24 dynamic load exclusion FFRD consequences exclusion is
25 a novel application, although one anticipated in the

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1 1989 Commission Policy Statement on Additional
2 Application of Leak-Before-Break Technology.

3 It, nevertheless, follows the same
4 underlying regulatory logic: a phenomenon that arises
5 only as a consequence of a particular initiating event
6 need not be included in the design basis if that event
7 is of extremely low likelihood and is preceded by
8 observable leakage that provides operators adequate
9 time to bring the plant to a stable shutdown
10 condition.

11 ALS does not seek to change 10 CFR 50.46.
12 Full ECCS analysis for breaks up to and including the
13 double-ended guillotine break is still required. The
14 ALS establishes only that FFRD may not be modeled with
15 those analyses for plants meeting SE applicability
16 limitations and conditions.

17 Leak-before-break credit applies solely to
18 whether FFRD must be included in design-basis
19 analysis. It does not alter ECCS sizing or
20 performance requirements. Same with design basis for
21 environmental qualification.

22 This preservation of the constraint
23 established under GL 84-04 is an important aspect of
24 the ALS's consistency with the existing regulatory
25 framework.

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1 EPRI's 2020 scoping study evaluated a
2 risk-informed approach as an alternative pathway.
3 That approach showed greater feasibility with leak-
4 before-break credit than without it. The decision to
5 pursue leak-before-break-based pathway reflects a
6 judgment about regulatory precedent and schedule.

7 The ALS uses risk insights, that is, the
8 extreme rarity of large break LOCAs probabilistic
9 fracture mechanics, as supporting evidence rather than
10 as the primary regulatory vehicle, which is consistent
11 with a defense-in-depth perspective.

12 It is important to note that the ALS does
13 not constitute a complete licensing basis extending
14 the maximum allowable burnup from the current 62
15 gigawatt days per metric ton limit to 75 gigawatt days
16 per metric ton.

17 Other safety analyses remain necessary
18 complement to ALS. These include analyses addressing
19 mechanical performance, pellet-cladding interaction,
20 fission gas release, cladding oxidation, and other
21 design-basis events that could result in fuel failure
22 at higher burnup.

23 Staff review and completeness.

24 The NRC staff reviewed the ALS TR against
25 the existing regulatory framework for ECCS analysis

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1 and leak-before-break qualification. Evaluating
2 technical adequacy are reached here and the conditions
3 necessary for plant-specific implementation.

4 The SE incorporates the L&Cs described in
5 Appendix A in the ALS TR. These include:

6 1. Compliance with SE limitations and
7 conditions and the accompanying EPRI TRs.

8 I'll skip the numbering there.

9 2. Prior NRC authorization leak-before-
10 break for main RCS loop piping.

11 3. An approved coolant system leak
12 monitoring program meeting Regulatory Guide 1.45
13 requirements.

14 And 4. A no-burst condition demonstration
15 using NRC-approved LOCA evaluation models and plant
16 safety analyses.

17 These are all well-aligned with ALS
18 technical basis. Each plant-specific license
19 amendment request must confirm satisfaction of all
20 limitations and conditions. The SE conditions require
21 confirmation that existing programs and analyses
22 satisfy the specified requirements, and should not be
23 assumed to be automatically satisfied based solely on
24 prior licensing action.

25 As part of this review, staff performed an

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1 independent thermal hydraulic analysis to bound the
2 effect of fuel dispersal on ECCS performance, using
3 conservative assumptions about fragment bed geometry
4 and location. Safety issue number 3 in the SE.

5 ACRS acknowledges that this analysis
6 provides a useful bounding perspective for this TR.
7 However, TRACE does not have the capability to
8 mechanistically simulate fuel relocation and dispersal
9 phenomena. Rather, the staff's analyses -- analysis
10 assumed fragment configurations. Thus, the margin it
11 demonstrates is sensitive to the conservatisms in
12 those assumptions.

13 While a sensitivity study provides useful
14 additional insight in support of the ALS proposal, we
15 caution against its use as a substitute in
16 applications where fuel dispersal behavior is a
17 primary determinant of safety margin.

18 Precedent setting aspects and scope
19 boundaries.

20 The ALS establishes regulatory precedent
21 that warrants careful characterization. This is the
22 first instance in which leak-before-break
23 qualification has been used to exclude a specific
24 LOCA-induced safety consequence other than a
25 structural dynamic load from 10 CFR 50.46 ECCS design

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1 basis.

2 ACRS offers the following observations on
3 the nature and limits of this precedent.

4 1. Precedent is bounded by the SE
5 limitations and conditions, leaving those in the
6 accompanying EPRI Topical Reports. Leak conditions,
7 that is prior leak-before-break authorization,
8 Regulatory Guide 1.45-compliant leak monitoring, and
9 demonstrated no-burst for sub-main loop breaks are
10 specific to the FFRD context and require confirmation
11 that existing programs and analyses satisfy these
12 conditions.

13 ALS approval does not create a general
14 pathway for excluding other phenomena from the
15 licensing basis or leak-before-break arguments.

16 The precedent depends on the continued
17 validity of leak-before-break authorization for main
18 loop piping and at each plant adopting ALS. Changes
19 in plant configuration, materials condition, water
20 chemistry or inspection finding that the effect leak-
21 before-break qualification would bear directly on ALS
22 applicability.

23 We observe that the aging management
24 programs and ISI requirements that underpin leak-
25 before-break authorization, including ASME Section XI,

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1 GALL-SLR commitments, and technical specification
2 leakage limits also underpin the ALS basis.

3 The absence of the compatibility to
4 mechanistic model FFRD consequences may become
5 increasingly important as the ALS precedent is applied
6 to configurations or burnup limits beyond those
7 examined in the current SE. We caution against the
8 use of assumed fragment-based approaches for future
9 assessments that may not have the same robust leak-
10 before-break-based technical justification as the
11 present ALS.

12 Summary.

13 The EPRI ALS is grounded in established
14 regulatory precedent and provides a technically sound
15 approach to the safety issues posed by LOCA-induced
16 FFRD and high-burnup PWR fuel.

17 ALS employs a 3-tiered structure which
18 includes first use of leak-before-break qualification
19 to exclude a LOCA-induced safety consequence for large
20 break LOCAs, supported by xLRP probabilistic fracture
21 mechanics analysis; a no-burst demonstration for small
22 and intermediate break LOCAs; and a defense-in-depth
23 assessment of non-piping RCS components through
24 existing regulatory commitments.

25 This structure is logically coherent and

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1 adequately supported. This conclusion is further
2 supported by demonstrated leak detection inspection
3 and degradation management programs that provide high
4 confidence in leakage detectability and timely
5 operator response.

6 Both the ALS TR and staff SE clarify leak-
7 before-break credit is limited to under LOCA-induced
8 FFRD must be analyzed within the design basis, does
9 not alter ECCS-sizing performance, containment design,
10 or environmental qualification.

11 Further, ALS does not constitute a
12 complete licensing basis for non-LOCA design-basis
13 events resulting in fuel failure at higher burnup.
14 Separate regulatory action will, therefore, be
15 required for those events.

16 The Committee also notes that the absence
17 of the capability to mechanistically model FFRD
18 consequences may represent residual limitation in the
19 analytical framework, one that may become more
20 significant as ALS is applied more broadly or burnup
21 limits are raised further.

22 The staff SE, with its stated limitations
23 and conditions, provides a technically adequate basis
24 for approval of the ALS TR, and the Committee supports
25 its issuance.

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1 We are not requesting a formal response to
2 this letter.

3 Member Harrington did not participate in
4 the Committee's deliberations regarding this matter.

5 Sincerely, Greg Halnon, Chairman.

6 CHAIR HALNON: Thank you, Bob. Take a
7 break. Good job.

8 Okay. At this point with the letter read
9 in, I'm going to open up the lines to public comment.

10 If there's anybody online, please raise
11 your hand. Again, remember that if you're on the
12 phone it's Star-5 to raise your hand. And we'll take
13 your public comment.

14 Dr. Lyman, you're up.

15 DR. LYMAN: Thanks. This is Edwin Lyman
16 from the Union of Concerned Scientists. I just have
17 one, actually two comments.

18 So, I didn't see anything explicitly about
19 seismic loads and their impact on the assumption of
20 the low frequency of large break associated with leak-
21 before-break. And I know that was maybe covered in
22 the background documents, but I think explicit
23 reference to it might be helpful because I don't
24 understand how it was made to go away. And the other
25 issue, I know outside of the scope of the committee is

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1 sabotage, which is another initiating event which
2 would have an unpredictable impact on the frequency of
3 large break LOCA.

4 So, those are two unanswered questions in
5 my mind related to this analysis.

6 Thank you.

7 CHAIR HALNON: Thank you, Ed.

8 Any other comments from folks online?

9 (No response.)

10 CHAIR HALNON: Anyone from in the room?

11 (No response.)

12 CHAIR HALNON: Okay. I'll go ahead and
13 close public comments.

14 At this point I believe we can release the
15 court reporter Sandra.

16 You are released for the remainder of the
17 meeting. We will not require your services for the
18 rest of the week.

19 Thank you for being with us this morning.

20 (Whereupon, the above-entitled matter went
21 off the record at 9:28 a.m.)

22

23

24

25