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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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730TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

OPEN SESSION

+ + + + +

WEDNESDAY, NOVEMBER 5, 2025

+ + + + +

The Committee met via Video-
Teleconference, at 8:30 a.m. EST, Walter Kirchner,
Chair, presiding.

MEMBERS PRESENT:

WALTER L. KIRCHNER, Chair

GREGORY H. HALNON, Vice Chair

VICKI M. BIER, Member

VESNA B. DIMITRIJEVIC, Member

CRAIG D. HARRINGTON, Member

ROBERT P. MARTIN, Member

SCOTT P. PALMTAG, Member

DAVID A. PETTI, Member

THOMAS E. ROBERTS, Member

MATTHEW W. SUNSERI, Member

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DESIGNATED FEDERAL OFFICIAL:

LAWRENCE BURKHART

ALSO PRESENT:

JOSH BORROMEO, NRR

EDWIN LYMAN, Public Participant

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

8:30 a.m.

CHAIR KIRCHNER: Good morning, the meeting will now come to order. This is the first day of the 730th meeting of the Advisory Committee on Reactor Safeguards, ACRS. I am Walt Kirchner, Chairman of the ACRS.

Due to the continued lapse in appropriations for government funding, this meeting is being conducted virtually. In addition, the ACRS is authorized to perform only those activities that have been designated by the Agency as high priority. Consequently, we have made some adjustments to the meeting agenda that was published in the Federal Register on October 1st, 2025. I will mention these changes later in my opening remarks.

ACRS members participating virtually are Vicki Bier, Vesna Dimitrijevic, Gregory Halnon, Craig Harrington, Robert Martin, Scott Palmtag, Dave Petti, Tom Roberts and Matt Sunseri. If I have missed anyone, please speak up now. I note that we have a quorum for today's meeting.

Larry Burkhart of the ACRS staff is the Designated Federal Officer for this morning's full Committee meeting. No member conflicts of interest

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1 were identified for this morning.

2 The ACRS was established by the Atomic
3 Energy Act and is governed by the Federal Advisory
4 Committee Act, FACA. Under the Atomic Energy Act,
5 ACRS shall advise the Nuclear Regulatory Commission on
6 the hazards of proposed and existing reactor
7 facilities and the adequacy of proposed safety
8 standards.

9 Following Executive Order 14300, the
10 Committee has narrowed its focus to only those
11 activities necessary to fulfill its statutory
12 obligations. As a result, the ACRS is prioritizing
13 the review and reporting of new reactor facilities and
14 proposed safety standards with particular attention to
15 issues that are unique, novel and noteworthy. The
16 Committee will consider other nuclear safety matters
17 at the direction of the Commission.

18 Please note that the ACRS speaks only
19 through its published letter reports. All member
20 comments should be regarded as only the individual
21 opinion of that member and not a Committee position.
22 Information about ACRS activities, such as letters,
23 rules for meeting participation and transcripts, are
24 on the NRC public website and can be found by
25 searching About Us, ACRS on the NRC's home page.

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1 The ACRS, consistent with the Agency's
2 value of public transparency and regulation of nuclear
3 facilities, provides opportunity for public input and
4 comment during our proceedings. We have received
5 several written statements from members of the public
6 for a topic that was on the published agenda, the
7 Palisades Steam Generator Operational Assessment;
8 however, due to the lapse in appropriations, this
9 topic will no longer be addressed in this meeting.
10 The ACRS will capture these written statements in a
11 summary report and the certified minutes from this
12 meeting.

13 Another topic that was removed from the
14 original agenda is the Westinghouse Topical Report on
15 the Adaption of the FULL SPECTRUM LOCA Evaluation
16 Methodology to perform analyses of cladding rupture
17 for high burnup fuel. At this time, we are not
18 certain whether these topics will be rescheduled by
19 the ACRS at a later date. If they are rescheduled,
20 they will be posted on our public website.

21 Therefore, the only topics that remain on
22 this meeting's agenda are the Kemmerer Construction
23 Permit Application letter report and our Planning and
24 Procedures, P&P, Session. Discussions during the
25 Planning and Procedures Session will be limited to

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1 higher priority activities. There were no written
2 statements or requests to make an oral statement from
3 the public on the two topics I mentioned, any further
4 written statements may be forwarded to today's
5 Designated Federal Officer. And we have also set
6 aside time this morning for public comments.

7 Just another note about possible changes
8 to the agenda, due to the removal of the two topics I
9 just discussed, the Planning and Procedures Session
10 may be moved from Friday to tomorrow, Thursday.

11 A transcript of the meeting is being kept
12 and will be posted on our website. When addressing
13 the Committee, the participants should first identify
14 themselves and speak with sufficient clarity and
15 volume so that they may be readily heard. If you are
16 not speaking, please mute your computer on Teams. If
17 you are participating by phone, press star six to mute
18 your phone and star five to raise your hand on Teams.

19 The Teams chat feature is only for
20 communicating IT issues or brief meeting logistical
21 topics. Please do not use it for comments or
22 questions on the topics under discussion by the
23 Committee.

24 Finally, if you have any feedback for the
25 ACRS about today's meeting, we encourage you to fill

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1 out the Public Meeting Feedback form on the NRC's
2 website.

3 Before proceeding, I would like to this
4 opportunity to acknowledge the service of one of our
5 colleagues, Member Vesna Dimitrijevic, who is
6 completing her second term this month. This will be
7 her last ACRS meeting. Vesna, your keen insights,
8 collegial interactions with members and staff and
9 especially your contributions in the PRA area where
10 you have been an expert practitioner now for many
11 years, going back to studying under Norm Rasmussen at
12 MIT, your contributions have materially helped this
13 Committee complete its work. Your views on PRA and
14 overall reactor safety are much valued and we will
15 miss you professionally and personally.

16 In particular, I will miss your long
17 distance commentary on matters before the Committee.
18 Very often you get us refocused on the substantive
19 safety matters at hand. So on behalf of the
20 Committee, Vesna, thank you very much.

21 At this point, if any of my colleagues
22 would like to make a comment, please go ahead.

23 All right, hearing none, during today's
24 meeting, the Committee will consider the Kemmerer
25 Construction Permit Application Review. And so with

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1 that, I'll turn the Committee's deliberations over to
2 our TerraPower Subcommittee Chairman, Tom Roberts.
3 Tom, go ahead.

4 MEMBER ROBERTS: Thank you, Mr. Chairman.
5 Good morning, as Walt said, I'm going to summarize the
6 subcommittee review of the safety aspects of the
7 construction permit application for TerraPower Sodium
8 Reactor at a site in Kemmerer, Wyoming.

9 This application was accepted for review
10 by the NRC staff in May of 2024 and they intend to
11 complete the review by the end of this month. The
12 ACRS review is part of the process of NRC review of a
13 construction permit application as required by the
14 Atomic Energy Act. We focused our review on aspects
15 of the application that affect safety and are unique,
16 novel or noteworthy. Sandra, can you bring up the
17 next slide? Thank you.

18 The reactor that is proposed to be
19 constructed in Kemmerer is called a Sodium reactor.
20 It's an 840 megawatt thermal sodium fast reactor.
21 When thinking about what might be unique, novel or
22 noteworthy about it, the U.S. has experience in sodium
23 fast reactors which is leveraged by the Sodium
24 design, but much of this experience such as EBR-II,
25 the Fast Flux Test Facility, the PRISM design, are

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1 more than 30 years old. This reactor is also the
2 first non-light water reactor power reactor to submit
3 a construction permit application, the first to use a
4 licensing modernization project as the basis for the
5 safety case and the first to use the 10 CFR 50.160 new
6 emergency planning rule for small modular reactors and
7 other new technologies.

8 We had a fairly large field of areas that
9 we could screen as novel, noteworthy or unique that
10 were worthy of review. So Sandra, next slide.

11 Back in July and September, we reviewed a
12 potential list of areas that we would define as
13 unique, novel or noteworthy and worthy of focus in our
14 review. When we looked through the documents, the
15 safety documents, the Preliminary Safety Analysis
16 Report and the Topical Reports, we came up with four
17 major areas that we thought were worthy of our focus
18 in the review. Three of them are what are generally
19 called fundamental safety functions and that's control
20 of heat generation or control of the reactivity or
21 power control for the plant.

22 Control of the heat removal, a fundamental
23 safety function, which is removal of heat once the
24 reactor has been shut down and still a significant
25 amount of decay heat that needs to be accommodated

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1 over the next days, weeks and months.

2 For the third fundamental safety function,
3 it's retention of radionuclides which is usually known
4 as containment or in this case called a functional
5 containment. In those three areas, we had more
6 detailed sub-focus areas that I'll talk about in a
7 couple of minutes, but those were the three
8 fundamental safety functions we chose to review.

9 The last category is a little different
10 than the fundamental safety functions. It's really a
11 catch all given the use of the licensing modernization
12 project, the unique aspects of this plant design,
13 called the sufficiency of the overall safety case.
14 For example, the LMP approach is very much centered on
15 a probabilistic risk assessment and so we wanted to
16 take a look at that and then see if the overall safety
17 case, at least at the stage of the construction
18 permit, would be sufficient.

19 Then, we noted at the time, that other
20 areas may arise as a result of subcommittee
21 discussions, so I'll mention that briefly as we go on.
22 Sandra, next slide.

23 We had two subcommittee meetings. They
24 were both multi-day subcommittee meetings. One was
25 two days early in the month of October when we focused

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1 mainly on the overall plant design and the
2 implementation of the licensing modernization project
3 approach for licensing and safety justification.
4 Then, two weeks later, we had a meeting that focused
5 mainly on structures, systems and components, where
6 the aspects of the plant design that implement the
7 safety aspect, and we also had some follow-up during
8 that week on some of the open discussion items from
9 the previous meeting.

10 Those two meetings worked, I thought, very
11 well to address the focus areas and at the end of the
12 second subcommittee meeting, we went through the
13 detailed focus areas and I'm going to go through them
14 again for the full Committee just to review how we
15 resolved the areas that we identified as focus areas.
16 Sandra, if you can go the next slide. Thank you.

17 The first fundamental safety function was
18 the control of heat generation. We identified three
19 specific areas under that heading that we thought were
20 worth poking into. One is sensitivity of reactivity
21 events. There is a long history with sodium fast
22 reactors that because of the potential for significant
23 reactivity excursion caused by either boiling of
24 sodium or core geometry changes, you could have
25 potential consequences that could affect the reactor

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1 vessel integrity or the integrity of containment
2 potentially depending on the magnitude of that
3 excursion.

4 The plan for Sodium was to not consider
5 that in the safety basis and so we wanted to
6 understand why. We poked at that in some detail and
7 we found that there were some significant aspects of
8 the plant design that were either different than
9 previous generations of these reactors or were
10 accounted for based on more knowledge or upgraded
11 models of various phenomena. For example, the design
12 uses a metallic fuel as opposed to an oxidized fuel.
13 The metallic fuel has characteristics that the
14 Applicant and the NRC staff explained make it very
15 unlikely that even if you had a situation with core
16 melt and a reactivity potential rearrangement of fuel,
17 the likelihood of a reactivity excursion is very low
18 just because of the physical and the chemical
19 properties of the metal fuel. We go into that in a
20 little bit more detail in the draft letter that we'll
21 read in later this morning.

22 The second major aspect is that the
23 likelihood of events, because of the safety features
24 that were included in this plant make it very, very
25 unlikely to even get to the point where you're in the

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1 range of having the fuel melt that could lead to core
2 geometry changes. The Applicant evaluated some
3 scenarios that were very, very unlikely and at least
4 as of yet, they have yet to come up with a scenario
5 that would even come to that. So when you combine
6 those two arguments, it's a strong argument to not
7 bias the design for these events that are somewhat
8 hypothetical in nature.

9 The second area that we looked at in this
10 category was the claim of two means of rod insertion
11 but all the means of rod insertion were driven by the
12 same reactor protective system. While the design had
13 been evolved since the Preliminary Safety Analysis
14 Report was first written, the Applicant had added a
15 second diverse means to insert rods, so that was an
16 excellent response to that concern. That concern
17 really no longer exists.

18 Finally, the limitations on rate of rod-
19 based reactivity insertion. The design includes non-
20 safety interlocks to limit the rate that the rods can
21 insert reactivity to bounds that are covered in the
22 analysis and we wondered why those were non-safety,
23 given the importance of limited reactivity insertion
24 rate. During the progression of the NRC staff review,
25 the staff and the Applicant identified a need to

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1 reassess the safety classification of these interlocks
2 and so the Applicant will re-look at that as part of
3 the analyses that go into the operating license
4 submittal. Again, that's an issue that's identified
5 and being worked, so again, that was resolved. Next
6 slide.

7 The next fundamental safety function that
8 we focused on was the heat removal safety function and
9 we identified two areas. One is the reliability of
10 passive cooling. The design is passive, relies on
11 natural circulation heat transfer so when you lose
12 electrical power, the coolant circulates naturally,
13 transfers heat through various boundaries to get out
14 to the ultimate heat sink which is the environment.
15 There are two diverse means of removing decay heat,
16 but they both rely on a combination of air flow and
17 natural circulation. We discussed that and the
18 Applicant has a plan to get the data they need and
19 further advance the design going into the operating
20 license. We didn't see any show stoppers from the
21 actions that the Applicant identified that they
22 planned to pursue during the time between now and the
23 operating license.

24 The other one was the transition from
25 forced circulation to natural circulation. The

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1 Preliminary Safety Analysis Report defined the pump
2 coastdown as a required safety feature that by
3 coasting down the pump speed relatively gradually, you
4 could transition to natural circulation. That raised
5 the question of what if you had a pump failure that
6 precluded the ability to coast down, like a seizure of
7 the pump rod or that type of thing. The Applicant
8 identified that they were looking at, in the design of
9 the pump, enough capability in the pump such as gaps
10 around the rotor to maintain the transition even if
11 the pump were to stop rotating more suddenly. That
12 was identified in a report that was issued as a
13 supplement to the Preliminary Safety Analysis Report
14 and that was issued in the last month or two. Again,
15 based on staff questions and their own advancement of
16 the design, they were working on that. So, we thought
17 that resolved our question there. Next slide.

18 The retention of radionuclides fundamental
19 safety function is usually known as containment. This
20 design is the first sodium fast reactor to use the
21 functional containment strategy that was approved by
22 the NRC back in the 2019 time frame. We wanted to
23 understand because the functional containment concept
24 really came from different technologies, such as high-
25 temperature gas reactors, we wanted to understand how

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1 to apply the sodium fast reactor. So we poked at that
2 pretty hard. We actually looked at that in some
3 previous Topical Report reviews and then we looked at
4 it again at both of the meetings. We concluded a
5 number of things. One, is the licensing modernization
6 project methodology leverages the mechanism of source
7 term concept that evaluates based on events that are
8 deemed to be likely enough to be included, which also
9 includes assessment of the so-called cliff-edge
10 effects that I'll get to in a minute, where events
11 that aren't expected to happen but still because if
12 they did happen they would change the safety
13 performance significantly. There is a wide range of
14 events that are looked at to determine what is
15 required for containment.

16 By the time the Applicant got through that
17 process, they ended up with a containment that looked
18 a lot like prior SFR containments. When you look at
19 it, it has boundaries, barriers that are defined, that
20 are tested, that have safety classifications, although
21 they may be somewhat different than they would be
22 under the previous regime, where you would define what
23 the boundaries are and don't base them strictly on
24 analysis. But one important point is they ended up at
25 about the same place as they would have if they had

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1 followed precedent and just designed a containment
2 that met historic characteristics of sodium fast
3 reactor containments, so that was point number one.

4 Now, point number two was looking at the
5 overall design, the reason why the LMP process came up
6 with such low risk in terms of the number of scenarios
7 and the types of scenarios that would challenge a
8 containment, was because of safety enhancements that
9 the Applicant made in the design compared to prior
10 generation SFRs. We've got in the draft letter a list
11 of some of those features, but there are significant
12 enhancements, such as redundant means of passive decay
13 heat removal, the characteristics of the metal fuel
14 that have benefits such as low amounts of stored
15 energy and, as I mentioned a couple of slides ago,
16 less of a likelihood of reaching a condition that has
17 a higher reactivity than the original core.

18 Just going through the safety
19 enhancements, it seemed reasonable that the LMP
20 produced results that supported the containment
21 design. They appear to be reasonable and they will be
22 fully validated during the operating license. We
23 ended up concluding that the approach to the
24 functional containment was reasonable for the stage of
25 design that they're at and there is confidence that

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1 the Applicant will be able to get there and finish the
2 justification as part of the operating license phase.

3 The other area on radionuclide retention
4 that we have focused on was the sodium fires. The
5 Preliminary Safety Analysis Report wasn't really clear
6 on things like guard pipes or guard vessels or those
7 types of things to have double containment to keep
8 sodium from interacting with air that could
9 potentially lead to a significant chemical explosion
10 or fire. The staff and the Applicant have been also
11 working on the same question and since we started the
12 review, there was a section added to chapter 8 of the
13 Preliminary Safety Analysis Report to more fully
14 explain their strategy and to better explain the
15 double containment that they plan to have for any area
16 that's at risk of these types of interactions. And so
17 it appeared to us that the Applicant was working on
18 the right things and there is more work to go before
19 the operating license submittal, but again it looked
20 like they had given enough to support the safety at
21 the construction permit level. Next slide.

22 The last category that we identified for
23 focus was the sufficiency of the overall safety case.
24 We focused on cliff-edge effects. If you look at the
25 LMP process, there are some relatively general

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1 requirements in the LMP process documents to consider
2 the potential for cliff-edge effects for scenarios
3 that don't screen in based on expected frequency of
4 occurrence, but if they were to occur because of basic
5 uncertainties and the ability to define all the
6 scenarios that can occur, that they would
7 significantly change the outcomes of the event to the
8 extent that it would affect safety. So the Applicant
9 is required to assess those but the LMP process
10 documents are a bit light on how, so we wanted to hear
11 from the Applicant on how they're handling that.

12 And the next focus area, I'll cover the
13 two together, which was related but a little bit
14 different so we had to call it out as a separate sub-
15 focus, is the Applicant defined a subset of events
16 that they called other quantified events. They were
17 events that were included that were below the
18 frequency thresholds that the LMP process required to
19 be considered as licensing basis events. But it
20 wasn't entirely clear what their criteria were for
21 them and so we wanted to understand better what those
22 were. Those two had really the same discussion and
23 resolution in the subcommittee meeting.

24 Basically, their approach is anything in
25 their PRA, any sequence of events they could think of,

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1 they included as another quantified event. That would
2 include cliff-edge effects, things that might test the
3 adequacy of defense-in-depth, those types of things
4 because they basically didn't screen anything out from
5 the standpoint of considering them as other quantified
6 events.

7 In terms of the criteria, their accepted
8 criteria was -- a little back of background, the
9 licensing modernization program uses a frequency-
10 consequence curve that says that basically the less
11 frequent you think an event is, the more consequence
12 you could tolerate and there is a frequency cutoff
13 which is 5 times 10 to the minus 7 or 1 in 2 million
14 years. So, an event that is less frequent than 1 in
15 2 million years has no dose criterion. An event that
16 is right at that threshold, 1 in 2 million years has
17 a threshold of roughly 1,000 rem over 30 days at the
18 site boundary.

19 What the Applicant did was they took that
20 1,000 rem criterion for the cutoff frequency and
21 applied it to every OQE, every event. So, basically
22 any event they could think of, if it ends up being as
23 bad as what would be allowed at the frequency cutoff,
24 they will assess whether or not design changes are
25 warranted to improve defense-in-depth or make the

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1 frequency less, so make it less likely.

2 That seemed like a reasonable approach and
3 they also pointed out they hadn't found anything yet
4 that would have that kind of dose based on the nature
5 of their design and so there's more work yet to go to
6 confirm that, but thought it was a reasonable approach
7 to be thinking about it from that standpoint that no
8 matter what the perceived frequency is, they will look
9 at it and the dose consequence if it ends up being
10 what would be allowable within the space of a
11 licensing basis event, they will assess actions.
12 Again, we thought that covered that item.

13 The last item that we identified in our
14 initial list was the seismic design, just the
15 application of a seismic isolation system to the
16 entire reactor enclosure is new. Seismic interactions
17 can be important to reactivity control, if you move
18 around the metal fuel within the core that could
19 change the reactivity and so we wanted to make sure
20 that was looked at. In sum, the work done on the
21 seismic isolation system appears sound, there's more
22 work to go, but that work appears sound. All the
23 questions that we had on the seismic design were
24 answered so that seemed like it was, again, well under
25 way for the stage of a construction permit.

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1 I mentioned at the outset that we also
2 would consider any additional focus areas that came
3 out of the discussions and we found after the
4 subcommittee meetings, we had thorough presentations
5 from both the Applicant and the staff and we did not
6 identify additional focus areas based on what we heard
7 during the subcommittee meetings, so this ended up
8 being the complete list of what we focused on. Next
9 slide.

10 We concluded we had enough information to
11 proceed to a draft letter. We concluded that we did
12 not need to have presentations from the Applicant or
13 from the staff. They are probably online listening
14 and they'd certainly be free to correct anything I
15 said, but we didn't see a need to have any
16 presentations from them. I'd note at the end of this,
17 we're prepared to read the draft letter into the
18 record after we've had a chance for further
19 discussion.

20 So with that, I'd like to invite any
21 members of the subcommittee to make a comment or
22 correct what I said or add to it. Okay, hearing none,
23 I guess I offer if the Applicant or the NRC staff
24 wants to make a comment, there's no need to, but if
25 there's something you'd like to either correct or

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1 amplify on the record, now would be a good time.
2 Josh?

3 MR. BORROMEIO: Yeah, so this is Josh
4 Borromeo and I'm Chief of the Advanced Reactor
5 Licensing Branch in the Office of Nuclear Reactor
6 Regulation. I do just want to highlight my
7 appreciation for ACRS and their flexibility in
8 reviewing this review that we did for USO's
9 construction permit. I think it was efficient and
10 effective and I just wanted to highlight that in this
11 forum. Thank you.

12 MEMBER ROBERTS: Okay, thank you, Josh.
13 Okay, I'm not seeing any other requests to make a
14 comment, so with that, Mr. Chairman, I'll turn the
15 meeting back over to you.

16 CHAIR KIRCHNER: Thank you, Tom, for your
17 report. At this point, what I would like to propose
18 is that we take public comments. What I'm going to
19 ask people, I'd like to start with comments first on
20 the Kemmerer CPA application. If there are any
21 members of the public who would like to comment on
22 that, please raise your hand and we'll go through
23 those first and then I recognize that there were other
24 topics on our agenda and we'll give an opportunity for
25 short comments from the public on those other two

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1 matters.

2 I see Ed Lyman's hand up. Ed, go ahead.

3 DR. LYMAN: Thank you. This is Edwin
4 Lyman from the Union of Concerned Scientists. I'd
5 just like to reiterate some of the comments that I
6 made during the subcommittee meetings. I guess I'm
7 disappointed that the Committee seems prepared to sign
8 off on some of the more safety significant aspects of
9 what I see as an unsafe design, in particular, the
10 issue of functional containment.

11 This is, again, an unprecedented feature
12 that's been before the Committee. Given the
13 restrictions on the future ACRS deliberations, this
14 may be the only time that you're going to have the
15 opportunity to fully assess a functional containment
16 for any other subsequent design because it may not be
17 noteworthy or unique anymore. So you really need to
18 think very carefully about what you're doing at this
19 point. The key here is confirmation. What I see here
20 is a paper design of a novel reactor where many of the
21 features that are being discussed certainly have not
22 been tested to the point that they can be used to
23 validate any of the models that have been going into
24 calculating either probabilities or consequences of
25 the licensing basis events. Because of that, this is

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1 essentially a prototype reactor.

2 The rules, unfortunately, have a gap in
3 that for construction permits, they don't have to
4 satisfy the requirements of the combined operating
5 license with regard to prototype demonstrations, but
6 I think that is a gap that is really a historical
7 problem. In fact, because this is essentially a
8 prototype reactor, it may warrant having additional
9 safety features that may not be needed for subsequent
10 units, but because it is a prototype, I think you'd
11 want to think very carefully about whether to
12 unequivocally sign off on the functional containment
13 and ask yourself one question. If, during the
14 operating license review, some of the assumptions are
15 not fully validated, would there really be a situation
16 where the staff would require a retrofit of a more
17 conventional containment? I think the answer is
18 pretty clearly no and because of that, this is a very
19 consequential decision at this point and, again, I
20 urge the Committee to think very carefully about what
21 you're doing, and in particular, the issue of
22 reactivity excursions.

23 I should note that most of the details of
24 the more severe events have really not been presented
25 to the public. Every time they come up, the Committee

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1 has gone into a closed session and as a result, I'm
2 not persuaded that there are not the potential for
3 severe, fast-acting power excursions due to changes in
4 the state of the reactor that could potentially
5 overwhelm the so-called functional containment. As a
6 result, I'm not persuaded that this prototype reactor,
7 this experimental paper reactor, does not need
8 additional safety features like a full containment to
9 address the potential for these rapid power excursion
10 possibilities. And the fact that the preliminary
11 analyses at this point show that they're a low
12 probability, again, is not persuasive given the lack
13 of validation.

14 I'd also like to point out that even
15 though it's not within the Committee's purview, which
16 I think is unfortunate, the potential for sabotage
17 events is another factor that should be going into
18 this determination, but is simply not a part of this
19 discussion. But it really needs to be because again,
20 any of these low probability events could be induced
21 by sabotage attack and therefore, they may not be as
22 low probability as you think. I'll conclude my
23 remarks there. Thank you.

24 CHAIR KIRCHNER: Thank you, Ed. Any other
25 comments from the public participating? I'll start

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1 again with Kemmerer CPA. Okay, seeing no hands
2 raised, we will turn now to public comments on the
3 other two topics that were previously on the agenda,
4 the Palisades Plant and the Westinghouse FULL SPECTRUM
5 LOCA TR. Let me ask you to keep your comments
6 succinct, concise and to the point. With that, I'll
7 open the floor for comments. Just raise your hand and
8 we'll recognize you in the order that we see you
9 expressing interest in making a comment. Okay, Larry,
10 as our Designated Federal Officer, I do not see any
11 hands raised.

12 MR. BURKHART: Yes, I agree, I agree.

13 CHAIR KIRCHNER: So, at this point then,
14 we'll close our public comment period and return to
15 our agenda. I think I noted, Vesna, are you there?
16 I think you joined us after we started.

17 MEMBER DIMITRIJEVIC: Yes, I'm here. I
18 had a problem on the one computer, so I switched to
19 the other one.

20 CHAIR KIRCHNER: Okay, well, while you
21 were --

22 MEMBER DIMITRIJEVIC: But I'm here.

23 CHAIR KIRCHNER: Okay, excellent. While
24 you were switching computers, I hope your ears were
25 ringing. So, let me just repeat again some comments

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1 I made. And that is that we wanted to acknowledge
2 your service as you complete your second term on the
3 Committee and this will be your last meeting with us.

4 Your keen insights and collegial
5 interactions with members and staff, especially in
6 topics in the PRA area where you have been an expert
7 practitioner now for many years, going back to your
8 PhD work with Norm Rasmussen at MIT, your
9 contributions have significantly helped this Committee
10 complete its work. Your views on PRA and overall
11 reactor safety are much valued.

12 We will miss you professionally and
13 personally and, in particular, I will miss your long
14 distance commentary on matters before the Committee
15 very often getting us refocused on the substantive
16 safety matters at hand. So on behalf of the
17 Committee, thank you, Vesna.

18 MEMBER DIMITRIJEVIC: Well, thank you. I
19 will miss you guys too, thanks.

20 CHAIR KIRCHNER: Okay and with that now
21 we're going to turn back to Member Roberts, who will
22 have a letter report draft to read into the record.
23 Go ahead, Tom, I think we're ready for your reading.

24 MEMBER ROBERTS: Okay. Can you hear me?

25 CHAIR KIRCHNER: Yes.

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1 MEMBER ROBERTS: Okay, good. Okay, I'll
2 skip the very beginning part there. Subject: Report
3 on the safety aspects of the construction permit
4 application for TerraPower Natrium reactor at the
5 Kemmerer Power Station. Dear Chairman Wright, during
6 the 730th meeting of the Advisory Committee for
7 Reactor Safeguards on November 5th through 7th, 2025,
8 we completed our review of the safety aspects of the
9 construction permit application for Unit 1 at the
10 Kemmerer Power Station and NRC staff's associated
11 Safety Evaluation Report with no open items.

12 Our TerraPower Design Centered
13 Subcommittee reviewed this matter during subcommittee
14 meetings on October 8th to 9th and October 21 to 23,
15 2025. During these meetings, we had the benefit of
16 discussions with NRC staff and representatives from
17 the Applicant, TerraPower, and there is a footnote
18 that explains that the construction permit application
19 was submitted by TerraPower, LLC on behalf of US SFR
20 Owner LLC or USO, a wholly owned subsidiary of
21 TerraPower. For simplicity, this letter report refers
22 to TerraPower as the Applicant -- so, just to avoid
23 some confusion with TerraPower or USO or whatever, we
24 wanted to use the same term throughout for clarity.

25 Going back, we also had the benefit of the

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1 reference documents. This report fulfills the
2 requirements of Section 182(b) of the Atomic Energy
3 Act as amended. Footnote 2, just excerpts the portion
4 of Section 182(b) that that's referring to.

5 Okay, conclusions and recommendations.
6 One, the reactor design for the Kemmerer Power Station
7 is a TerraPower Sodium pool type metal fueled, sodium
8 cooled fast reactor, or SFR. The Sodium design
9 include safety advantages when compared to prior
10 generation SFRs, including two means of passive heat
11 removal, two diverse means of generating scram trips
12 and significant separation between the sodium and the
13 steam systems. The design does not require electrical
14 power or operator intervention to achieve a safe
15 shutdown.

16 Two, the Kemmerer CPA is the first
17 application for a power reactor to use the licensing
18 modernization project, or LMP, methodology that was
19 endorsed by the NRC staff in 2020. This methodology
20 focuses the safety case on those items most important
21 to overall risk with increased use of the
22 probabilistic risk assessment, PRA. We consider the
23 Applicant's implementation of this methodology to be
24 adequate for this stage of licensing and consistent
25 with the Commission's risk-informed performance-based

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1 policy of advanced reactors.

2 Three, in their SER, the staff concludes
3 there is reasonable assurance that the proposed
4 facility can be constructed and operated at the
5 proposed location without undue risk to the health and
6 safety of the public. This conclusion is based on an
7 expectation that the Applicant will provide further
8 technical or design information required to complete
9 the safety analysis in the Final Safety Analysis
10 Report, or FSAR, prior to the operating license
11 review. We agree.

12 Four, this letter report identifies
13 several areas we will revisit during our review of the
14 OL application, including detailed justification on
15 the functional containment design and the consequences
16 of reactivity accidents, validation of the passive
17 cooling design, integration of the PRA and defense-in-
18 depth assessments, and quantification of analytical
19 uncertainties. We encourage the Applicant and NRC
20 staff to address them prior to our OL review.

21 And then five, the construction permit for
22 Kemmerer Power Station Unit 1 should be issued.

23 Okay, background. The Kemmerer Power
24 Station consists of one TerraPower-designed Sodium
25 SFR rated to provide 840 megawatts thermal along with

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1 required power conversion equipment to generate 336
2 megawatts electrical steady state and 500 megawatts
3 electrical peak electrical power. Key features of
4 this plant design include the following: a nuclear
5 island that includes the reactor core within a sodium
6 pool and an intermediate heat transfer system that
7 uses liquid sodium to transport heat from the sodium
8 pool to a sodium to molten salt heat exchanger. The
9 nuclear island also includes structures, systems and
10 components required to provide the fundamental safety
11 function and control of heat generation, reactivity
12 control, control of heat removal which is decay heat
13 removal, and retention of radionuclides, which is
14 containment.

15 An energy island that uses molten salt to
16 store and transfer heat for further use, such as a
17 steam generator or to power a turbine generator.
18 Because normal operation of fault conditions in the
19 energy island are not expected to affect reactor
20 safety, the Applicant has designated all SFCs in the
21 energy island as non-safety.

22 The Preliminary Safety Analysis Report,
23 also called PSAR, provided to support the construction
24 permit application, was prepared using the LMP
25 methodology. Footnote 3 is a reference to the

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1 documents that define what the LMP methodology is,
2 just to avoid having a five-line parenthetical here in
3 the text. This approach to safety justification is
4 based primarily on a PRA supported by hazards analysis
5 and supplemented by explicit assessment of safety
6 margins and defense-in-depth. The CPA is the first
7 application to be submitted to the NRC using the LMP
8 methodology.

9 Okay, discussion. Approach to our review.
10 Our review of the safety aspects of the Kemmerer CPA
11 was focused on areas that we identified as potentially
12 unique, novel or noteworthy in application.

13 Appendix 1 of this letter report is a
14 detailed list of those focus areas. They are
15 summarized as follows:

16 First major bullet, implementation of
17 fundamental safety functions. Then sub-bullet,
18 control of heat generation, for example, reactivity
19 control. How are the unique reactivity
20 characteristics of fast spectrum reactors, such as the
21 potential for an increase in reactivity on core
22 geometry changes, accounted for and what design
23 features are included to mitigate them?

24 Control of heat removal, for example,
25 decay heat removal. How are the different passive

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1 means of decay heat removal and their assumed
2 reliability validated?

3 Retention of radionuclides, such as
4 containment. The Sodium reactor is the first SFR to
5 use a functional containment approach. What
6 relaxations were made relative to the historical
7 approach to SFR containment and how are they
8 justified?

9 And second major bullet, adequacy of the
10 overall safety case. Does this first use of the LMP
11 methodology provide sufficient justification to issue
12 a construction permit?

13 Okay, next section, control of heat
14 generation, e.g., reactivity control. The Sodium
15 design uses active, passive and inherent means of
16 reactivity control to control heat generation. When
17 required by upset conditions such as plant transients,
18 control rods can be inserted into the reactor core.
19 Two control banks of diversified geometrical design
20 are inserted into the core by the control rod drive
21 system employing active and passive means. The scram
22 function results in passive gravity insertion of
23 control rods into the reactor core to control heat
24 generation. Gravity insertion will occur when
25 reactive trip breakers, or RTBs, open via either of

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1 two diverse systems: the reactor protective system,
2 which removes power to the RTB under a voltage trip
3 circuits based on any of several plant parameter
4 sensors; or two, as described by the Applicant, the
5 quote alternative shunt trip system that is not
6 detailed in the PSAR, but will use parameter sensors
7 and interfacing circuitry that are diverse from the
8 RPS to trip the reactor trip breakers using their
9 active shunt trip circuits.

10 In either case, the reactor trip breakers
11 remove power from scram system solenoid valves that
12 then open to vent scram pistons, delatching the
13 control rods and allowing them to drop due to gravity.

14 Next bullet. The drive line scram follow
15 function results in active insertion of the control
16 rods using the control rod drive motors when the RPS
17 or alternative shunt trip system generate a scram
18 signal. This feature provides defense-in-depth in
19 case control rods fail to delatch.

20 Inherent reactivity feedback
21 characteristics of the reactor core also substantially
22 contribute to the control of heat generation. As fuel
23 and coolant temperatures rise, the combined effects of
24 various physical and physics-based feedback mechanisms
25 result in net negative reactivity feedback within the

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1 core that reduces power. Their combined effect is a
2 safe and stable power level at which heat production
3 and heat removal are in balance and importantly,
4 provides a strong inherent response to counteract any
5 anticipated reactivity excursions.

6 Past SFR designs considered the
7 possibility that common cause failures could result in
8 loss of the active, passive, and inherent features
9 that act in control heat generation. Specifically,
10 they included consideration of a hypothetical core
11 disruptive accident, or HCDA, where an accident caused
12 by failure of the active and passive features was
13 postulated to relocate fissile material into a more
14 reactive configuration and thereby, also perturb the
15 inherent reactivity control features. An HCDA could
16 potentially lead to an energetic transient with
17 consequences such as pressure driven leakage of sodium
18 coolant from the reactor vessel into containment. And
19 the footnote is a reference to a report that explains
20 that phenomenon in more detail.

21 TerraPower and the NRC staff explain that
22 HCDAs will be shown to be incredible as part of the
23 Operating License Application and their consequence
24 will not be specifically considered as part of plant
25 design and safety analysis. The safety case is

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1 expected to include one, design features that make
2 accidents that lead to potential for
3 melting/relocation of fuel extremely unlikely; and
4 two, characteristics of metal fuel that make energetic
5 reactivity transients unlikely even if fuel
6 melting/relocation were to occur, particularly when
7 compared to prior generations of sodium fast reactors
8 that use oxide fuel.

9 Appendix 2 of this letter report
10 summarizes the justification provided by the Applicant
11 and NRC staff. We plan to further evaluate this
12 justification when we review the Operating License
13 Application.

14 Part of the justification to exclude an
15 HCDA from the safety basis is analysis that is
16 expected to demonstrate that unprotected events, such
17 as rod withdrawal or loss of flow without scram will
18 not lead to fuel melt. These analyses assume certain
19 bounds on the severity of the unprotected transients,
20 specifically only one control rod is assumed withdrawn
21 and the loss of flow is assumed to be caused by de-
22 energization of primary sodium pumps whose rotors then
23 coast down.

24 More severe transients are possible.
25 Withdrawal of more than one rod is precluded by a non-

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1 safety rod withdrawal interlock, pump failures which
2 cause pump rotor stoppage without a coastdown will be
3 mitigated by a pump design that allows enough bypass
4 flow to establish natural circulation and prevent fuel
5 melt.

6 TerraPower intends to review the safety
7 classification of preventive controls, such as the rod
8 withdrawal interlock, prior to submitting any
9 Operating License Application. We agree this review
10 is warranted and believe the evaluation of a dual
11 locked rotator scenario to provide defense-in-depth
12 for such an unlikely transient will be an important
13 detail for the Operating License Application.

14 Okay, next major heading is control of
15 heat removal, e.g., decay heat removal. The Sodium
16 design uses active and passive means to control heat
17 removal. Two diverse residual heat removal systems,
18 the intermediate air cooling system, IAC, and the
19 rapid air cooling system, or RAC, provide -- perform
20 these functions. The IAC system provides means that
21 are active and passive while the RAC system provides
22 passive means of removing decay heat.

23 The reliance of an active circulation of
24 sodium coolant to transfer heat to air is common in
25 both the IAC and RAC systems. The Operating License

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1 Application is expected to have more information on
2 the technical bases to confirm effective natural
3 circulation flow and heat transfer from sodium to
4 air. For example, models of natural circulation
5 flow will need to be validated, as well as, heat
6 transfer from the core to the ultimate heat sink
7 through various interfaces, such as the reactor
8 vessel to guard vessel gap.

9 Additionally, both the IAC and RAC
10 systems rely on air flow through long passages that
11 could be blocked due to natural phenomena and means
12 to reliably keep such air passages open will need to
13 be demonstrated.

14 Okay, new heading, retention of
15 radionuclides, e.g., containment. The Natrium
16 design performs a fundamental safety function of
17 retaining radionuclides using a functional
18 containment strategy that employs diverse passive
19 barriers to ensure regulatory dose criteria and
20 quantitative health objectives are met. These
21 barriers begin in a radionuclide source and include
22 all structure systems and components between that
23 source and the environment.

24 The functional containment strategy
25 consists of: one, the safety-related, or SR, primary

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1 functional containment boundary defined as the
2 minimum set of barriers encompassing the core and
3 primary systems that prevent a release of
4 radionuclides from exceeding regulatory limits; and
5 two, enveloping barriers defined as either a non-
6 safety-related, NST, or non-safety-related with
7 special treatment, NSRST, structure systems and
8 components that provide a backup radionuclide
9 retention function to the primary functional
10 containment boundary it envelops.

11 Under LMP, the distinction between
12 primary and enveloping barriers and whether they are
13 designated as safety-related or not as established
14 through their relative safety significance.

15 In addition to the physical barriers, an
16 important inherent plant design feature supporting
17 the functional containment strategy is the high
18 boiling point of sodium relative to operational
19 coolant and fuel temperatures. This ensures that
20 the reactor core remains covered by sub-cold sodium
21 at near atmospheric pressure during licensing basis
22 events.

23 The low operating pressure of the
24 primary system and sodium cover gas ensures there is
25 no significant driving force to energetically

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1 transport radionuclides away from the reactor.

2 The Sodium reactor is the first SFR
3 design to use a functional containment strategy.
4 TerraPower and the NRC staff stated that the
5 functional containment barriers described in the
6 piece are reflected to meet radiological dose
7 criteria for the mechanism or source term associated
8 with the full range of accident scenarios considered
9 under LMP. This includes assessment of the most
10 limiting design basis accident to support regulatory
11 requirements in 10 CFR 50 and the footnote quotes
12 the requirement, which is in sub-part 34 of 10 CFR
13 50.

14 Accident analyses to be performed in
15 support of the Operating License Application are
16 expected to confirm adequacy of the selected
17 barriers. The primary and enveloping physical
18 barriers that were selected to meet the LMP
19 frequency-consequence guidelines share many
20 similarities with prior SFR containment designs,
21 such as accredited physical barriers with leak rate
22 limits and planned testing through plant life to
23 confirm those limits continue to be met.

24 The principal differences from prior SFR
25 containments resulting from the functional

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1 containment approach are higher leak rate limits
2 than prior designs and non-safety designations for
3 certain components of the enveloping barriers. When
4 compared to prior SFR designs, the Sodium reactor
5 has several safety enhancements as described in
6 Appendix 2 resulting in what is expected to be a net
7 reduction of risk despite these changes to
8 containment design. Therefore, it is reasonable to
9 expect that the functional containment approach can
10 be fully justified during the operating license
11 phase.

12 We expect to further review the
13 functional containment approach during our review of
14 the OL application with continued focus on the
15 adequacy of the supporting accident analyses and the
16 design and testing approaches as they compare to
17 traditional containment designs.

18 One of the primary goals of the
19 containment system for an SFR is to contain the
20 effects of a fire caused by chemical interaction of
21 sodium with air. The Sodium design has two
22 barriers between its sodium coolant and air, the
23 reactor vessel and guard vessel with sodium in the
24 core, the piping and guard piping or vessels for
25 risk significant parts of the intermediate sodium

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1 loop, the piping and catch pads for non-risk
2 significant parts of the intermediate sodium loop
3 and guard piping or inert cells for parts of the
4 sodium processing system. These design choices
5 limit the risk of fire from a sodium air
6 interaction; however, given the difficulty in
7 fighting sodium fires, more details about sodium
8 fire progression models and the fire protection
9 program are needed to support the fire risk
10 assessment that will be performed as part of the
11 operating license.

12 Radionuclide retention during accident
13 conditions will also depend upon the sodium salt
14 heat exchanger being a reliable pressure boundary.
15 The sodium salt heat exchanger couples the nuclear
16 and energy islands. Ongoing R&D by TerraPower is
17 addressing materials, compatibility, reaction
18 energetics and leak detection and isolation methods.
19 The design concept is innovative but remains one of
20 the least material elements of the plant and
21 continued progress in these areas will be important
22 to the safety case at the OL stage.

23 New heading, adequacy of the overall
24 safety case. First up heading, application of LMP.
25 The Kemmerer CPA is the first application to use the

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1 LMP methodology. Implementation of this methodology
2 is consequently an important element in assessing
3 the adequacy of the safety case. The LMP
4 methodology is centered around use of a PRA to
5 select licensing basis events, LBEs, determine
6 appropriate safety classification of structures,
7 systems or components, SSCs, assign associated risk-
8 informed special treatments and determine adequacy
9 of defense-in-depth.

10 While the LMP methodology is well
11 defined, its rigorous implementation may require
12 further development of processes and procedures.
13 The NRC staff stated they are evaluating this CPA
14 for lessons learned of potential clarifications with
15 associated NRC guidance. One area we observed was
16 TerraPower's approach to implementing the LMP
17 approach, the LMP guidance rather, for defense-in-
18 depth. They used a methodical, quote, defense line,
19 end quote, approach where every group of licensing
20 basis events was assessed against the LMP five layer
21 defense-in-depth model to assure appropriate
22 independence and diversity in system design and
23 operation.

24 TerraPower stated that the linkage
25 between these defense lines, key safety functions

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1 and quantifiable performance measures will continue
2 to develop through final design and the Operating
3 License Application. This will ensure traceability
4 from principal design criteria to assess
5 completeness of the PRA, defense-in-depth, and
6 assess for cliff-edge effects. We encourage
7 development of such approaches as they have the
8 potential to apply to the principal of defense-in-
9 depth in a straightforward manner.

10 The LMP methodology uses a frequency-
11 consequence curve that specifies acceptable dose
12 consequence limits that get larger with reducing
13 event frequency. For event sequences with a
14 frequency less than a 5 times 10 to the minus 7 per
15 year cutoff, LMP does not specify a dose limit, but
16 requires consideration of these very low frequency
17 sequences to assess for cliff-edge effects and
18 assure adequacy of defense-in-depth. The Kemmerer
19 construction permit application uses the term other
20 quantified events, or OQE, to refer to such events.
21 However, the PSAR is not consistent on the cliff-
22 edge effects or what acceptance criteria are used
23 when assessing other quantified events.

24 During our subcommittee meetings in
25 October 2025, TerraPower explained that their review

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1 for cliff-edge effects and defense-in-depth adequacy
2 will address in areas that meet either of two
3 conditions. One, the scenario has an estimated
4 frequency of occurrence of 1 times 10 to the minus 7
5 or greater with a 95 percent confidence level; and
6 two, any scenario regardless of frequency that has a
7 consequence of greater than 1,000 rem total
8 effective dose equivalent over 30 days in the
9 exclusion area or boundary.

10 The intent of evaluating the OQEs is to
11 determine if any low frequency events are
12 sufficiently consequential to consider additional
13 mitigation. TerraPower further stated they had not
14 yet encountered a scenario with a dose level high
15 enough to warrant this further evaluation, even
16 considering events such as unprotected reactivity
17 emissions and the losses of flow. We expect to
18 further review these conclusions as part of our
19 Operating License Application review.

20 Subheading, seismic isolation system.
21 One specific design feature considered to be novel
22 is the use of a seismic isolation system for the
23 reactor enclosure building. The design approach is
24 embedded in the reactor building substructure and
25 the seismic isolation system to support the reactor

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1 and enhance protecting against seismic events.
2 TerraPower is following the general lead of the GE
3 PRISM design of the 1980s, which envisioned using
4 steel and rubber isolation devices to support the
5 reactor and provide seismic protection.

6 We observed that the interfaces between
7 SSE supported by the seismic isolation system and
8 those outside the system, such as connections to
9 intermediate heat transfer system piping, will
10 warrant special attention to ensure that the
11 relative deflections between components supported by
12 seismic constraints and those that are not are
13 appropriately addressed.

14 We also observed that phenomena such as
15 reactivity response and seismic forces may be
16 relatively new for an SFR design and their impacts
17 may not have been fully explored in the past. There
18 could be surprises once the Applicant gets into the
19 details and this should be thoroughly explored when
20 the OL application is submitted.

21 Last subheading, treatment of analytical
22 uncertainties. Some of the calculations required to
23 support the safety case are much more involved and
24 complex than for other reactor technologies and the
25 PSAR does not include discussion of the

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1 uncertainties for available margins. These analyses
2 will be refined as the design proceeds from the CP
3 stage to the OL stage. It will be important to
4 establish the margins to figures of merit that are
5 used to assess whether principal design criteria are
6 met. While in the end there may be sufficient
7 margin, the uncertainties associated with these
8 calculations need to be established and assessed for
9 acceptability at the OL stage.

10 We believe the following sources of
11 uncertainty should be addressed in the OL
12 application and subsequent Safety Evaluation Report:
13 Reactivity feedback coefficients depend on complex
14 calculations of the deformation of the fuel rods as
15 restrained by the core restraint system including
16 the effects of the lower grid plate. Moreover,
17 point kinetics may not capture the three dimensional
18 nature of the response of the core and 3D kinetics
19 may be necessary. The uncertainties associated with
20 these calculations and the margin to avoiding a net
21 positive reactivity coefficient should be
22 documented.

23 Calculations related to confirmation of
24 acceptable fuel integrity and safety-related
25 structural materials in general depend on detailed

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1 thermomechanical analysis and the uncertainty and
2 the predicted response, stress, strain, creep
3 rupture, et cetera, that are not discussed in the
4 PSAR or referenced in Topical Reports. In
5 particular, analysis of the margin to the eutectic
6 melt, a key metric for fuel failure, is needed.
7 These values should be documented.

8 Summary. TerraPower has sufficiently
9 completed the early phases of risk-informed safety
10 case using the LMP approach to justify approval of
11 their construction permit for a Sodium sodium fast
12 reactor at a site in Kemmerer, Wyoming. This
13 application is supported by safety improvements
14 associated with the Sodium reactor design, which is
15 significant when compared to large light water
16 reactors and prior generation SFRs and can be
17 leveraged to support simplifications, such as use of
18 a functional containment approach in design and
19 analysis.

20 We look forward to reviewing the final
21 safety case when it is submitted with an application
22 for an operating license. The construction permit
23 should be issued. We are not requesting a formal
24 response from the staff to this letter. Sincerely,
25 Chairman.

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1 I'll take a short break there, page
2 through, there is enclosures and references I won't
3 read them. There are two appendices that were
4 mentioned in the body of the letter. And, yeah,
5 Sandra, if you go to the appendices, I'll start to
6 read the appendices.

7 Okay, Appendix 1, just a little
8 background. This is the document that we had
9 discussed in the July and September full Committee
10 meetings. And for the record, we wanted to capture
11 it so this was written before the review and so, you
12 know, obviously the review addressed many of these,
13 but again, just to capture for the record, this is
14 what we set out to review as the focus areas.

15 So, title is Unique, Novel, and
16 Noteworthy Elements. The focused ACRS review of the
17 TerraPower Sodium construction permit application.
18 Purpose: This appendix lists elements of the
19 TerraPower Sodium construction permit application
20 that are unique, novel and/or noteworthy were
21 identified prior to the subcommittee review meetings
22 as areas of focus for the ACRS' review of this
23 construction permit application.

24 Background. The TerraPower Sodium
25 design is an 840 megawatt thermal sodium fast

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1 reactor. While it leverages U.S. experience in
2 sodium fast reactors such as EBR-II, Fast Flux Test
3 Facility and the PRISM design, most experts more
4 than 30 years old, this reactor is also the first
5 non-light water power reactor to submit a
6 construction permit. The first to use the licensing
7 modernization project as the basis for its safety
8 case and the first to use the 10 CFR 50.160
9 immersive planning rule. Hence, there is a great
10 deal about this reactor construction permit
11 application that is unique, novel and/or noteworthy.

12 The challenge is to focus the ACRS
13 review of those items that were provided safety
14 assessment independent of that provided by the NRC
15 staff.

16 Discussion. The following four focus
17 areas for review are proposed. They are based on
18 the fundamental safety functions of controlled heat
19 generation, e.g., rapid rate control, controlling
20 heat removal, retention of radionuclides, e.g.,
21 containment and sophistication of the overall safety
22 case, e.g., use of the PRA-centered approach to
23 safety assessment.

24 Controlled heat generation, this is
25 largely set on with reactivity control. Aspects of

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1 reactivity control that are unique, novel and/or
2 noteworthy include: one, sensitive reactivity
3 events. Boiling of sodium can result in significant
4 reactivity excursion and reactivity of the core
5 called a hypothetical core disruptive accident.
6 While details are not included in the PSAR, the
7 Sodium safety case appears to be focused on showing
8 the sodium boiling or core derangement are so
9 unlikely as to not merit consideration in the safety
10 analyses.

11 Prior NRC assessments, such as the 1993
12 PRISM Preapplication Safety Evaluation Report, have
13 good assessments of such energetic reactivity
14 excursions even though they are considered to be
15 very unlikely. We should review the approach taken
16 by TerraPower.

17 Two: two means of rod insertion. The
18 PSAR takes credit for two groups of control rods
19 with different geometry in both passive gravity-
20 driven and active rod drive motor driven rod
21 insertion to meet requirements for two means of
22 scram. In both cases, the two presumed diverse
23 means of insertion are controlled by the same
24 reactor protective system, we see adequacy of
25 reliance on the same RPS for diverse means of

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1 insertion.

2 Three: limitations of rate of rod-based
3 reactivity insertion. The PSAR notes a reactivity
4 insertion rate is limited by interlocks that assure
5 only one rod is withdrawn at a time and that limit
6 rod speed. These features are not described in
7 detail, nor are they listed as safety significant in
8 the PSAR. We could review the role of these
9 interlocks in a safety system.

10 Four: control of heat removal. This is
11 implemented with a combination of a purely passive
12 system and the second system that has both active
13 and passive modes. Aspects that are unique, novel
14 and/or noteworthy include: one, reliability of
15 passive cooling. The margin in natural circulation
16 heat transfer relative to decay heat removal needs
17 to be confirmed. For example, the purely passive
18 system, the reactor air cooling system, or RAC,
19 relies on an air flow path that may be subject to
20 clogging due to debris. From the PSAR, it does not
21 appear that this entire flow path can be clean. We
22 should review plans to address uncertainties in this
23 system including whether we consider air flow paths,
24 any change from analytical assumptions to be
25 sufficiently reliable to support the passive

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1 function.

2 Two, transition from forced circulation
3 to natural circulation. The PSAR lists it's a
4 safety-related function of primary sodium pump
5 coastdown rate that is sufficiently slow to assure a
6 transition from forced circulation to natural
7 circulation through the reactor core. There is no
8 discussion of more extreme flow transients that
9 would occur with a mechanical failure of the pump,
10 such as on pump shaft shear or seizure of the
11 impeller. We should review the likelihood and
12 consequence of such a failure.

13 Retaining radionuclides. This is a
14 primary event of a functional containment and has
15 demonstrated analytically via a mechanism storage
16 term. Aspects of radionuclide retention that are
17 unique, novel and/or noteworthy include: one, first
18 application of a functional containment for an SFR.
19 As discussed in two prior Topical Report Reviews, a
20 functional containment approach has never been
21 applied for an SFR. The nature of functional
22 containment shares many similarities with prior SFR
23 containments with the differences being the safety
24 classification and the design leak rates. We should
25 review these differences to more fully understand

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1 them and why they are acceptable including
2 consideration of the potential for energetic
3 reactivity events as described above under
4 controlled heat generation.

5 Two, sodium fires. One of the principal
6 goals of an SFR containment is to retain a slow
7 leakage characteristics in the case of a chemical
8 reaction involving sodium. The PSAR does not
9 explain how the assumed magnitude of sodium leakage
10 and containment would be determined for the
11 containment integrity analysis. Additionally, prior
12 designs, such as PRISM, make extensive use of guard
13 pipes to double contain sodium in case of leakage.
14 The Natrium PSAR does not discuss guard pipes in
15 chapter 7, but instead appears to rely on
16 strategically located catch pans. We should review
17 the plan to either limit the energy of a sodium fire
18 or design a functional containment for them.

19 Sufficiency of the overall safety case.
20 As noted earlier, the Natrium design is the first
21 commercial power non-light water reactor to submit
22 an application based on the PRA-centered LMP. The
23 LMP includes process steps to evaluate uncertainties
24 and include appropriate defense-in-depth to cover
25 such uncertainties including cliff-edge effects.

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1 Aspects of this approach that are unique, novel
2 and/or noteworthy include: one, cliff-edge effects.
3 Very little detail is provided in the PSAR on the
4 process used to ensure all relevant hazards are
5 identified. Additionally, the ASME standard and NEI
6 18-04 do not explain how the cliff-edge
7 determination and defense-in-depth assessments are
8 done for event sequences that do not screen in as
9 licensing basis events or are not modeled in the
10 PRA, i.e., completeness uncertainty. We should
11 review their process for hazard evaluation, LBE
12 selection and cliff-edge screening.

13 Two: role of other quantified events,
14 OQEs. LMP uses a frequency-consequence curve that
15 does not define a dose consequence criterion for
16 event of sequences with a frequency lower than 5
17 times 10 to the minus 7 per year. Natrium includes
18 such extremely unlikely scenarios, designated as
19 OQEs, to ensure the mechanism, source, term and
20 functional containment analyses are bounding when
21 considering uncertainties. It is unclear from the
22 PSAR what dose consequence criteria apply to OQEs.
23 We should evaluate the role of OQEs as part of
24 consequence acceptance criteria.

25 And three: seismic design. The Kemmerer

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1 site is the first construction permit application
2 for a site west of the Mississippi River in some
3 time and resilience to earthquakes will be
4 particularly important to safety. The plant uses a
5 unique seismic isolation system for the reactor
6 enclosure system. We should review this and the
7 adequacy of the seismic design. And that's the end
8 of Appendix 1.

9 Okay Appendix 2? Yep, Appendix 2 is
10 Safety enhancements of the Sodium reactor design
11 relative to prior sodium-cooled fast reactors.

12 Purpose. This appendix enumerates some
13 of the safety enhancements in the Sodium design as
14 described by TerraPower and the NRC staff. The
15 licensing modernization process, LMP, methodology
16 leverages such safety enhancements to support the
17 approaches to the hypothetical core disruptive
18 accident, HCDA, and functional containment design
19 and the Sodium safety basis for Kemmerer Unit 1.

20 Background. As a risk-informed
21 methodology, LMP focuses on accident scenarios
22 determined via a probabilistic risk assessment, PRA,
23 and that gives source terms postulated events that
24 are deterministically judged to be bounding. Use of
25 a risk-informed approach can lead to differences in

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1 safety design and analysis. For Natrium, this
2 approach resulted in two significant changes
3 relative to earlier SFR designs.

4 One: prior SFR designs considered the
5 potential for an HCDA which is a hypothetical severe
6 event in an SFR characterized by a rapid,
7 uncontrolled increase in reactor power and
8 subsequent rearrangement of fuel into a more
9 reactive configuration. This could lead to a power
10 surge and an energy release that might challenge the
11 reactor containment. Such actions may be triggered
12 by a loss of coolant flow or a transient overpower
13 event, especially if the reactor fails to shutdown
14 automatically, known as unprotected events. For
15 Natrium, TerraPower does not include an HCDA in
16 their safety basis since it is not deemed to be
17 credible per the LMP risk-informed process.

18 Two: prior SFR designs included a
19 containment structure or set of structures with
20 characteristics specified by principal design
21 criteria that define low leakage barriers and safety
22 classifications. For Natrium, TerraPower designed a
23 functional containment that includes the barriers
24 shown to be needed by a mechanistic source term
25 analysis.

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1 Discussion. The Sodium reactor design
2 incorporates several important features that support
3 the LMP-based design decisions discussed above. And
4 bulletized list, a large sodium pool with a high
5 degree of thermal inertia, metal fuel which
6 significantly reduces the amount of stored energy
7 available for interaction between the fuel and the
8 coolant when compared to oxidized fuels previously
9 used, no addition of plutonium in the fuel, which
10 reduces the magnitude of the void reactivity worth
11 compared to other SFR fuel systems.

12 Two independent and diverse shutdown
13 mechanisms, gravity scram and motor-driven driveline
14 scram follow, each controlled by independent and
15 diverse trip systems, reactor protection system and
16 alternative shunt trip system, each of these
17 shutdown mechanisms inserts two diversely designed
18 sets of control rods.

19 Two independent decay heat removal
20 systems, the reactor air cooling system is passive
21 and is always on and the intermediate air cooling
22 system can operate in active and passive modes.

23 Two primary mechanical sodium pumps
24 whose design enables the transition from forced to
25 natural convection of sodium with timing pump

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1 coastdown.

2 Functional containment as supported by
3 improved understanding of fission product release
4 from metallic fuel and its associated transport in
5 sodium in the cover gas.

6 Separation of the energy island from the
7 nuclear island, which essentially eliminates the
8 potential for sodium water interaction. There is
9 potential for sodium salt interaction in the salt
10 heat exchanger, but TerraPower plans to prevent or
11 mitigate this interaction as described in chapter 13
12 of the Preliminary Safety Analysis Report.

13 Protection to be demonstrated for most
14 unprotected scenarios. The Applicant plans to
15 demonstrate that an unprotected reactivity addition
16 transient caused by unintended withdrawal of one
17 control rod and an unprotected loss of flow caused
18 by loss of power to the primary sodium pumps will
19 not lead to fuel melt or boiling of sodium.

20 Additional preventive features.
21 Unprotected transients complicated by failures such
22 as unintended withdrawal of multiple control rods or
23 locked rotor failures of both primary sodium pumps
24 would be required to possibly lead to fuel melt or
25 boiling of sodium. The Applicant intends to add

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1 defense-in-depth features such as rod withdrawal
2 interlocks and bypass flow in the sodium pumps to
3 mitigate locked rotor conditions to further lower
4 the likelihood of such outcomes.

5 And last bullet, reduce potential for
6 severe accidents to lead to an energetic reactivity
7 transient. Specifically, as discussed in reference
8 national laboratory documents, and there are two
9 footnoted reports, certain thermal and physical
10 properties of metal fuel make it unlikely that fuel
11 melt will lead to a reactivity addition,
12 particularly when compared to earlier designs that
13 use oxide fuel.

14 Conclusion. These features result in
15 the robust implementation of the key safety
16 functions in the plant. They demonstrably influence
17 plant safety by either reducing the frequency of
18 postulated events or reduce the associated
19 consequences. Thus, a significant reduction in the
20 overall risk profile of the plant is expected when
21 compared to previous SFR designs. It is reasonable
22 to expect that these safety improvements can be
23 leveraged in the Operating License Application to
24 fully justify the TerraPower conclusions that an
25 HCDA is not credible and that a functional

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1 containment strategy driven by robust mechanistic
2 source term analysis is technically sound.

3 And that is the end of the letter. I
4 guess, Mr. Chairman, I'll turn it back to you.

5 CHAIR KIRCHNER: Thank you, Tom. Okay,
6 at this juncture, I would propose that we take high
7 level comments from members before we get into line
8 by line review and deliberation about the details of
9 the letter report. And I see Matt's hand up, so
10 I'll turn first to Matt and then Dave Petti.

11 MEMBER SUNSERI: Thank you, Walt. Can
12 we go to recommendation -- or conclusion number
13 three at the top of the report? Okay, you know, I
14 know we're talking about the staff's SER. Their
15 conclusion that reasonable assurance that the
16 proposed facility can be constructed and operated at
17 the proposed location without undue risk to health
18 and safety of the public, the last words in this
19 paragraph is, we agree, and I don't think we should
20 be agreeing with the statement that it can be
21 operated at the proposed location without undue
22 risk.

23 I know there's this caveated sentence in
24 here that says the conclusion based on the
25 application, but, you know, we have plenty of

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1 examples throughout our letter report where there
2 has not been sufficient information to say that
3 there's reasonable assurance they can be operated,
4 so we either need to separate those two topics or
5 you all tell me that I'm wrong on this. But anyway,
6 I have some proposed wording that we can get to when
7 we get there, but -- and I know why the staff has
8 written it that way because they have some guidance,
9 but we don't have to agree with the staff and their
10 guidance. That's my comment.

11 CHAIR KIRCHNER: Thank you, Matt.

12 MEMBER ROBERTS: Yeah, if I could
13 respond.

14 CHAIR KIRCHNER: Okay, Tom.

15 MEMBER ROBERTS: The requirements for
16 10 CFR 50.35 pretty much define the scope of a
17 construction permit is what's in this paragraph that
18 there is a judgment being made about the ability to
19 operate the plant if the, you know, Applicant
20 follows through on all the commitments that are
21 defined in the construction permit application.
22 That is what it says and our conclusion number five
23 is the construction permit should be issued and so
24 that essentially is us agreeing with that because
25 that is what a construction permit is. So, I don't

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1 know if the words we agree are necessarily needed at
2 the end of three, if that's -- you know, I
3 understand the comment that you can certainly take
4 that first sentence in isolation and say that's
5 premature. We don't have to be on record as
6 agreeing with that statement here in three, but I
7 think when we say in five that we agree the CP
8 should be issued, we are agreeing with that, because
9 that's what a CP is.

10 (Simultaneous speaking.)

11 MEMBER SUNSERI: I would support just
12 taking the we agree out of three. That would be
13 fine with me.

14 MEMBER ROBERTS: Yeah, I'm okay with
15 that too because that -- it's implied by five, so I
16 don't think we need to say that so I'm okay with
17 that.

18 MEMBER SUNSERI: Thank you.

19 CHAIR KIRCHNER: Thank you, Matt. I
20 think Dave Petti was next.

21 MEMBER PETTI: My comment is just
22 something to consider with Tom reading the letter
23 and then the two appendices back to back, there
24 seemed to be a lot of repetitiveness and I
25 understand, you know, Appendix 1 was written before

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1 the review. It's just something I think that when
2 we get into the editing of the letter, we should
3 keep in mind if there's a way to make it less
4 repetitive.

5 CHAIR KIRCHNER: Okay.

6 MEMBER ROBERTS: Dave, when we get
7 there, we can certainly discuss that line by line,
8 but I think because if there was a desire to capture
9 what we agreed to in the September meeting for the
10 record, then taking things out because they were
11 discussed in the letter is almost abating the need
12 for the appendix because by definition everything in
13 that appendix we covered in the meeting and then we
14 covered in the letter. We can discuss
15 strategically. There is an option we discussed at
16 the September P&P meeting is to put that appendix in
17 the Summary Report of that meeting and leave it out
18 entirely. We could do that.

19 MEMBER PETTI: Okay.

20 MEMBER ROBERTS: But I would think that
21 we need to decide as a committee if we want to
22 capture for the record what we agreed to in the
23 September P&P meeting.

24 MEMBER PETTI: Yeah.

25 CHAIR KIRCHNER: Dave, my sense is it's

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1 more a reference almost than -- yes, it's redundant
2 and I'm glad to see that the letter is consistent
3 with it, but it's more reference material than -- as
4 long as the letter stands alone, we can debate how
5 we capture that. I think the important point we
6 need to make is that that list of unique, novel and
7 noteworthy is the Committee's list, developed by the
8 Committee going into our review and maybe we can
9 capture that somehow in the introduction to that
10 attachment, to that appendix.

11 MEMBER PETTI: Yeah. Okay.

12 CHAIR KIRCHNER: I saw Vicki's hand and
13 then Bob.

14 MEMBER BIER: These are kind of ultra-
15 high level comments that I don't think directly
16 relate to anything in the letter, but just a couple
17 of concerns that I have about the whole process, the
18 way it seems to be unfolding. When I look back at
19 the transcript from the earlier subcommittee
20 meetings and, you know, Bob commented, I think, at
21 one point that the review of the PRA, at least in
22 the material we saw from staff, he described it as a
23 two-finger compliance check.

24 As a PRA person, there is not very much
25 meat for me to get my hands into at this stage and,

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1 you know, especially if we are relying more on PRA
2 to say yes, things are safe, it seems a little odd
3 to be, you know, accepting the PRA results without
4 evaluating all the nitty gritty of how they got
5 there.

6 The other kind of high level concern I
7 have is with postponing things like the seismic PRA.
8 You know, I understand there's a lot that cannot be
9 done at the CP stage, like if you don't know where
10 the pipe hangers are going to be then it's kind of
11 hard to do a seismic PRA on, you know, a conceptual
12 design, but the construction permit is the place
13 where we approve the site. And if we are approving
14 the site without being able to look in detail at the
15 seismic implications of that site, it just seems a
16 little odd. So, like I said, those are just
17 concerns I have about the process. I don't think
18 they necessarily translate into any verbiage that
19 belongs in the letter, but I just wanted to get
20 those on the record. Thank you.

21 CHAIR KIRCHNER: Thank you, Vicki. Bob?

22 MEMBER MARTIN: Actually, I think there
23 is verbiage that can relate to Vicki's comment with
24 regard to the PRA. There's no reference to Reg
25 Guide 1.253, which, you know, very specifically

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1 describes the framework or the expectation for the
2 level of detail the PRA at the construction permit
3 phase and the mention of PRA in the letter without
4 that context might imply that it's more than what it
5 is. So, all I'm suggesting is that we, one, I
6 notice the Reg Guide 1.253 is not in the reference
7 list, so it should be in the reference list; and
8 two, sprinkle in a couple places just mention, you
9 know, the context the PRA is within that Reg Guide
10 and not something else, like 171 or something like
11 that or 174. Anyway, that was really my only
12 comment.

13 MEMBER BIER: That's helpful, Bob, thank
14 you.

15 CHAIR KIRCHNER: Greg?

16 VICE CHAIR HALNON: Yep, there I am,
17 thank you. Just a couple items. One is when we get
18 into this a little more, I just question the need
19 for Appendix 1 overall. It kind of goes back to
20 Dave's discussion about repetitiveness. It's past
21 stuff, it's not necessarily, in my mind, relevant to
22 the letter, other than the fact that the letter kind
23 of goes through all the topics themselves, but we
24 can talk about that some more later.

25 Larry, I want to just make sure you get

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1 the USO/TerraPower as the Applicant and NRC likes
2 it. We shorthand TerraPower and I think, Tom, you
3 had a footnote, but I couldn't see the footnote so
4 I'm not sure if that explains that or not.

5 Finally, the combination of three and
6 four conclusions gives me a little bit of pause in
7 the fact that it kind of goes back to what Matt was
8 talking about to some extent. The reasonable
9 assurance that the proposed facility can be operated
10 at the proposed location doesn't -- I don't know
11 that. I don't think I can agree that what we've
12 seen says that it can be operated at the proposed
13 location. It's not so much the proposed location,
14 it's the word operated. I mean it certainly can be
15 designed and constructed at the proposed location,
16 but the operations, there's so much more than just
17 the paper design that we've seen. So, a little bit
18 take pause at that word operated, I think that I
19 need to understand that a little bit better.

20 And then, when you get to four, it talks
21 about revisiting during the review of the operating
22 license. I'm not sure revisit is the right word for
23 it and I'm not sure that we can say that, you know,
24 the detailed justification of the functional
25 containment -- I think it's more detailed design of

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1 the proposed containment.

2 So, I'm a little bit -- maybe it's the
3 definite nature of the two that get to me a little
4 bit and I think that maybe some tweaks in the words
5 might be appropriate, but I'll think more on it,
6 Tom, I'm not sure what my resolution to my comment
7 is, which is I hate making comments without a
8 suggested resolution, but the bottom line is that I
9 think that we're a little bit too ahead of our skis
10 on the operations of it. I think that the revisit
11 word is a little bit too soft. That's my comment.

12 CHAIR KIRCHNER: Greg, I agree too. I
13 think number four could use some work going forward
14 and I think I kind of agree with you and Matt that
15 we need to be a little more careful. The things
16 that we feel need to be addressed are alluded to in
17 number four and based on the detailed design and
18 analysis that's presented at the OL phase, then one
19 perhaps can make the more definitive conclusion
20 about the operability, the safe operation of the
21 plant after it gets an operating license.

22 VICE CHAIR HALNON: Right.

23 MEMBER SUNSERI: Yeah, that was my point
24 exactly, I agree with both of you all.

25 CHAIR KIRCHNER: Larry, you have your

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1 hand up.

2 MR. BURKHART: Yeah, I just recommend
3 the Committee consider the conclusions and
4 recommendations that were written for both Kairos
5 CPAs and it basically says we agree with the staff
6 that there is confidence the facility can be
7 constructed in accordance with the relevant
8 regulations and the design bases outlined in the
9 PSAR. Detailed design analysis and technology
10 qualification will be completed prior to the
11 operating license, OL, review, that's from the
12 Committee's letter for Kairos 2.

13 CHAIR KIRCHNER: Good, thank you. At
14 this point, we're coming up to the top of the hour,
15 if there are not --

16 (Simultaneous speaking.)

17 VICE CHAIR HALNON: Walt, you got Vesna
18 still has her hand up.

19 CHAIR KIRCHNER: Oh, I'm sorry, Vesna, I
20 didn't see the hand. Go ahead, Vesna.

21 MEMBER DIMITRIJEVIC: Okay, so one of
22 the things I have Larry just addressed, that we
23 should separate that operation and the, you know,
24 the letter but I have two very high level comments.
25 In this letter, we talk about the Natrium all the

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1 time and we never talk about Kemmerer Unit 1, so we
2 are reviewing design or we are -- you know, the NRC
3 talk in the SER only about KU1 which is the Natrium,
4 so if we are just talking about the Natrium design
5 and also these differentiate between the location
6 and design and things like that. So, maybe we
7 should clear up somewhere in the letter the Natrium
8 versus Kemmerer Unit 1, you know? When we have the
9 discussion, so this is very high level.

10 The second very high level is also I
11 remember that we agreed that when we talk about the
12 Committee conclusions and our work, we can say we
13 and, you know, that's perfectly fine instead of the
14 Committee, but I think when we talk about the
15 future, you know, we will review this in three, we
16 will do this for the future work we should just say
17 the Committee because there is a difference between
18 we now and we, you know, five years from now or
19 things like that. So, that was my other high level
20 comment and I gave it to Tom, but he said we use, we
21 like 30 times in the letter.

22 CHAIR KIRCHNER: Okay.

23 MEMBER DIMITRIJEVIC: Okay, those were
24 my high level comments.

25 CHAIR KIRCHNER: Noted, thank you.

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1 Yeah. Other member comments, high level comments at
2 this point? Okay, then at this point, I think we --
3 Larry, correct me if I'm wrong, we can release the
4 court reporter?

5 MR. BURKHART: Yes, I agree.

6 CHAIR KIRCHNER: Okay, so thank you for
7 your service today. I will not need your service
8 for the rest of this meeting so thank you. And then
9 I propose, we're at the top of the hour, I propose
10 we take a 15-minute break to 10:15 and we'll pick up
11 our letter review. We're recessed until 10:15
12 Eastern Time.

13 (Whereupon, the above-entitled matter
14 went off the record at 10:00 a.m.)

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ACRS Subcommittee Review of Kemmerer Construction Permit Application

Thomas Roberts, SC Meeting Chairman

Advisory Committee on Reactor Safeguards (ACRS)

U.S. Nuclear Regulatory Commission



TerraPower Sodium Design

- The Sodium design is an 840 MWth sodium fast reactor.
- While it leverages U.S. experience in sodium fast reactors, such as EBR-II, Fast Flux Test Facility (FFTF) and the PRISM design, most of that experience is more than 30 years old.
- This reactor is also the first non-LWR power reactor to submit a CPA, the first to use the Licensing Modernization Project as the basis for its safety case, and the first to use the 10 CFR 50.160 emergency planning rule.
- Hence many aspects of this application are novel and/or noteworthy.

ACRS Focus Areas

- We selected four focus areas, three of which are defined as the “fundamental safety functions”, or FSFs:
 - Control of Heat Generation FSF (e.g., reactivity control)
 - Control of Heat Removal FSF (e.g., decay heat removal)
 - Retention of Radionuclides FSF (e.g., functional containment)
 - Sufficiency of the Overall safety case (e.g., PRA-centered LMP approach)
- Other areas may arise as a result of SC meeting discussions

Subcommittee Meetings

- The applicant and staff provided a comprehensive overview of the plant design and safety analyses as documented in the CPA.
 - October 8-9: Overall Plant Design and implementation of LMP
 - October 21-23: Structures, Systems, and Components
- These meetings satisfactorily addressed each of the focus areas, as discussed in the following slides.

Control of Heat Generation FSF

- Specific review areas include:
 - Sensitivity to reactivity events – Potential for significant reactivity excursions caused by boiling of sodium and core geometry changes
 - Two means of rod insertion – Reliance on the same reactor protection system to control presumably diverse means of rod insertion
 - Limitations on rate of rod-based reactivity insertion – Reliance on non-safety interlocks to limit reactivity insertion rate

Control of Heat Removal FSF

- Specific focus areas include:
 - Reliability of passive cooling – Margin in natural circulation heat transfer relative to decay heat removal needs
 - Transition from forced circulation to natural circulation – Scenarios that lead to a rapid reduction in pump speed and may therefore not transition to natural circulation

Retention of Radionuclides FSF

- Specific focus areas include:
 - First application of a functional containment for an SFR – The rationale for differences from prior SFR containments
 - Sodium Fires – The plan to either limit the energy from chemical reactions involving sodium or design the functional containment for them.

Sufficiency of the Overall Safety Case

- Specific focus areas include:
 - Cliff-edge effects – How the process for hazard evaluation, LBE selection, and cliff-edge screening adequately assess for cliff-edge effects and defense in depth.
 - Role of “Other Quantified Events” (OQEs) – The role of extremely unlikely Sodium scenarios evaluated by the applicant to ensure analyses are bounding when considering uncertainties.
 - Seismic design – The adequacy of the seismic design, since resilience to earthquakes will be particularly important to safety.

Conclusion

- The subcommittee has enough information to proceed to a draft letter report for deliberation by the Full Committee.
- We are prepared to read the draft letter into the record.

List of Acronyms

- ACRS – Advisory Committee on Reactor Safeguards
- CPA – Construction Permit Application
- EBR-II – Experimental Breeder Reactor - II
- FFTF – Fast Flux Test Facility
- FSF – Fundamental Safety Function
- LBE – Licensing Basis Event
- LMP – Licensing Modernization Project
- LWR – Light Water Reactor
- MWth – Megawatts, thermal
- OQE – Other Quantified Event
- PRA – Probabilistic Risk Assessment
- PRISM - Power Reactor Innovative Small Module
- SC - Subcommittee
- SFR – Sodium Fast Reactor